

CHEMICAL & METALLURGICAL ENGINEERING

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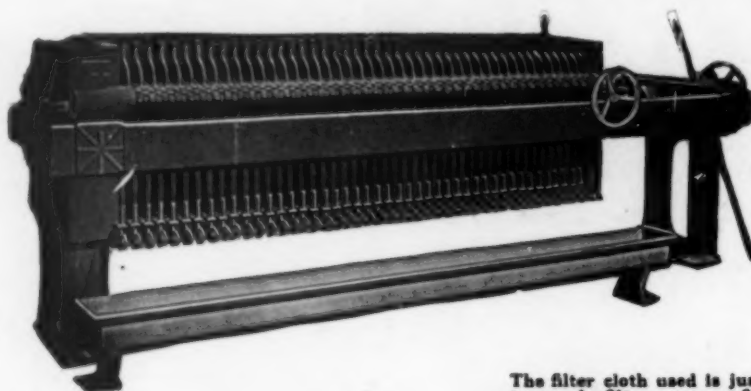
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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

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CHARLES WADSWORTH, 3D
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Volume 27

New York, November 15, 1922

Number 20

An Engineer As Ambassador

IN THE appointment of GELASIO CAETANI as Ambassador from Italy to the United States, engineers generally, but particularly mining and metallurgical engineers of the West, will find a new source of pride and gratification. We are no longer unaccustomed to the appointment of engineers to high places in civic affairs, but occasionally a conspicuous example like this excites our admiration. Our Western readers will recall Mr. CAETANI as a man of charming personality and an engineer of exceptional ability who made his mark in ore dressing. In a fine democratic spirit he began at the bottom, following his graduation from the Columbia School of Mines in 1903, and worked his way to recognition through sheer merit. To only a few of his friends was it known that he was the son of the Duke of Sermoneta, and a descendant of a noble Italian house that has been prominent in the national life of Italy for nearly a thousand years.

During the late war Mr. CAETANI served in the Italian army, rose to the rank of Colonel, and gained fame by destroying an Austrian stronghold, the Col di Lana. Since the armistice he has been a prominent figure in Italian affairs, first being elected Mayor of Rome, and subsequently serving as a member of the Chamber of Deputies. It is with this fine heritage that Mr. CAETANI will return to the United States as the Ambassador of his native country; and without disparagement of his eminent predecessors, we feel that he will bring qualities of mind and personality that will add fresh luster to this diplomatic post.

Specifications for A Government Post

IN THE resignation of Dr. STRATTON as director of the Bureau of Standards, the government finds itself confronted with no mean problem—that of discovering a successor technically fitted for the position and financially able to support it.

The Bureau of Standards is probably the greatest physical institution in the world, and in view of its close relation to science and industry it requires a many-sided director. But like most government posts, the salary is not commensurate with the requirements. And while it is a sad commentary on the unwillingness of the government properly to compensate its technical servants, the fact remains that in most of these positions the incumbent must accept honor as a large part of his remuneration.

Imagine a position in industry with the following requirements: (1) A knowledge of industry, from the practical rather than the academic point of view. (2) A broad and profound knowledge of the science of physics. (3) Ability to command the confidence of

Congress in order to obtain appropriations for projects of great importance but not particularly spectacular. (4) Administrative experience and executive ability. (5) A quality of social leadership among scientific men and laymen that will command respect for professional standards and scientific workers in the community. And then imagine the salary that would be offered to the happy possessor of these qualifications. It would certainly be several times that established for the director of the Bureau of Standards. And yet these are practically the specifications for the man to fill Dr. STRATTON's place. But if these were all the task might not be so difficult. We must still add the requirement of a private income sufficient to eke out the salary that Congress has seen fit to establish for the heads of scientific bureaus in Washington.

During the recent war it was not uncommon for men of exceptional ability to abandon their regular vocations and give their services to their country at nominal salaries. Such evidence of patriotism is not unexpected at a time of national crisis, but should not be called for in civil service in times of peace. The dollar-a-year man of war times has returned to his job, but we can almost find his counterpart in the scientific servants of the government today.

Treating Symptoms or Establishing Principles?

IT IS illustrative of our loose habits of thought, or disinclination to think at all, that there was a very favorable popular reaction to the announcement that Congress intended to set up a commission to "get the facts" in the coal industry. Apparently the public had an idea that there was confusion as to the facts. The miners had made various claims as to excessive capacity of coal mines, as to miners being very poorly employed in point of time, and the like. The public was probably assuming that the operators were denying most of the statements. As a matter of fact they were not, and they were making very few statements of their own.

In an industry that employs hundreds of thousands of men and produces hundreds of millions of tons a year there are naturally many facts. The coal commission will probably assemble thousands of facts, perhaps hundreds of thousands if the figures in the tables are counted as facts.

But the whole coal situation may be regarded as an industrial symptom. Here is an industry said to be overdeveloped, overcapitalized and overmanned. The natural laws of trade are expected to correct such conditions. Usually they do; in coal they do not. Surely we all know that this failure is not due to any essential economic quality of coal, differentiating it from iron ore, copper or zinc. If we suspected a difference, we should seek for a great mass of facts not simply in coal

but in all industries to show by comparison how it happens that coal is different.

The great fact in coal is one that requires no commission to find. It is simply that a great labor union has grown up in that industry, one of the results being that the law against restraint of trade is ineffective. For while that law forbids producers to agree with one another to restrict production, it does not forbid coal operators and coal miners from disagreeing with each other, whereby a restriction in production actually occurs.

Herein is involved a definite principle. Is it in accord with public policy to permit workmen to form unions and to permit the unions to restrict production? The tendency of labor unions in the United States is to do this. They do it in the building trades and they have done it with the railroads. These are the most powerful unions in the United States.

What has occurred in coal is merely an industrial symptom resulting from the practice of permitting labor unions to restrict operations. We do not need a great mass of facts about coal in this connection, showing how or to what extent they do it, what their various excuses are and how the money is divided that is thus obtained from the public. We know enough about that already.

What we need is clear thinking as to what principle should be laid down, as a matter of public policy, to govern the relations between employers and employed, whether the work is in coal mining or any other industry. Obviously the coal industry furnishes an excellent opportunity for experimenting in the application of any new principle we may adopt, but if harm is being done by our permitting restraint of trade by employees when we do not permit it by employers, it would be very unfortunate if we should act only when the restraint goes to such outrageous lengths as it has in coal. Public opinion needs to be formed, and for this leadership is usually requisite. Public opinion now holds that workmen will be imposed upon unless they are permitted some latitude. There is only dissatisfaction, and then not a great deal, when the latitude covers arson and murder. Let us adopt the principle, if we find it right, that workmen do need protection and then let us give them the protection freely and properly, instead of letting them commit crimes to protect themselves.

The Chemical Game Of Hide and Seek

A HIGHLY esteemed subscriber writes to ask if we cannot find place for a regular column or department devoted to the results of investigations that are in progress relative to atomic and molecular structures. These problems, he says, "are in a similar position to those of engineers not very long ago. When they desired to build a bridge they first made a model, then loaded it with sandbags, found where it gave way, made these parts stronger, and repeated the process until they finally concluded that the bridge was strong enough. Then, using the model as a criterion, the bridge was built with its stresses and strains computed by a 'cut and try' method. Today they know the characteristics of their materials, and, by simple mathematics, they compute the size of beams and braces when once the load is given." It seems to us he is harking back a considerable time in regard to general engineering methods, but that is not germane to the subject. He wants to see chemists at work, for example, at synthesis, having the facilities of the engineer to compute the units of his structure. So do we.

Our correspondent's appeal for more light is indeed the cry of the chemical world today. We need more study, more definitions and more understanding of chemical forces. Our power, our heat, and water flow, all come from the sun. When we burn coal we are recovering, as the late Professor CIAMICIAN said, the fossil energy of the sun. This is true in that the sun furnished the energy to bring about the endothermic synthesis of cellulose, lignin, gums, etc., in the trees and plants. But chemical energy comes from within the atom.

The Lewis-Langmuir theory is a grand beginning, although progress is slow. Here we have approximately definite geometrical shapes for atoms. The arrangement of protons and electrons is such that there is not complete balance of positive and negative charges on the faces of the atoms, except in those of the inert gases. The pair- and octet-forming drive of electrons in the presence of positive charges accounts for the wandering of electrons from one atom to another to make up or to approximate octets and thus form ions which are held together by electrostatic force, or to cause combined atoms to hold pairs of electrons in common. In this manner molecules are built up. Here is a world of study ahead to enable us to visualize every molecule.

Given this, and we have again a lack of balance on the several faces of the molecule, owing to the preponderance or greater proximity of either positive or negative charges to every face in question. These produce electropositive or electronegative fields of force over the molecular faces, and indicate a reason for the formation of crystals. Granted geometric shapes with definite and similar fields of force on the same face of each, then we can well imagine how the dominant electropositive face will attach itself and cleave to the dominant electronegative face of the molecules of a substance. This would provide for Sir WILLIAM BRAGG's crystal units made up, as he says, in quartz for instance, of three molecules of SiO_2 arranged in a particular and specific manner. The strongest fields of force would be within the crystal unit with electropositive and electronegative faces joined and held together by electrostatic force. But, so far as we are aware, we have not reached the study and computation of these fields of force as yet.

Within the domain of colloid chemistry the situation is, as usual, rather muddy, foggy, hazy and indefinite. Why is it that some substances form crystals and others do not—so far as we know? Or, granting the above reason for crystal formation, why are some substances amorphous? We are now over in the domain of armchair chemistry, without anything but imagination to help us. We do not know whether amorphous particles are made up of indefinite aggregations of molecules or of crystal units or of both. But suppose the fields of force on the faces of the molecules or crystal units are so evenly balanced that they join "at haphazard," as the saying is; then any electropositive face will join any electronegative face at haphazard, and the resulting aggregates will be irregular. And as soon as the surface of the particle becomes completely electropositive or completely electronegative, then aggregation will cease.

This is mere guessing, and yet it shows how fascinating the field is and how sorely we need additional study and research. Exposition should not be difficult in the end, if we could only get at the facts.

Political Fortunes Of Chemical Industry

ASIDE from its purely political aspects, the recent election has an incidence on chemistry in this country in so far as it determines the attitude of Congress toward our chemical industry. In the Senate we have lost two good friends, T. COLEMAN DU PONT of Delaware and J. S. FRELINGHUYSEN of New Jersey. On the other hand, WILLIAM H. KING of Utah was re-elected and we still have with us Senator MOSES of New Hampshire, both of whom are known to be unsympathetic with the hopes and aspirations of the chemical industry. In the House we have been fortunate in retaining Mr. LONGWORTH, while HERMAN METZ was defeated by OGDEN L. MILLS of New York. The defeat of Mr. VOLSTEAD may have some effect in getting fair treatment for industrial alcohol, because his place as chairman of the Judiciary Committee of the House probably will be taken by Mr. GRAHAM of Pennsylvania, who, we hope, will not be so absorbed in the administration of the prohibition features of the Volstead act that he will fail to recognize the mandate for the encouragement of industrial alcohol.

Intelligent Use of Fire Extinguishers

UNDER the caption "Turning Accident Into Disaster" we commented editorially in our issue of July 19, 1922, on an accident in one of New York's subways in which Pyrene was used to extinguish a fire resulting from an electric short circuit. Current press reports of the accident stated that a large number of passengers had been overcome by fumes of Pyrene and its decomposition products. Knowing something of the chemical properties and physiological effects of carbon tetrachloride, phosgene, chlorine and hydrochloric acid, and accepting as reliable the reports that passengers had been gassed and taken to hospitals for recovery, we drafted an editorial condemning the use of Pyrene in the subway and holding that its use had added to the disastrous consequences of the accident.

Subsequently the official report of investigation by the Transit Commission exonerated Pyrene as a factor in the distress and illness of the passengers. In the light of this report, which was summarized in our issue for Aug. 16, it is obviously incumbent upon us to retract our strictures on the use and effect of Pyrene as far as they pertain to this particular accident. In its investigation the Transit Commission had the benefit of the experience and service of experts from the U. S. Bureau of Mines who are competent authorities on the subject; and if they found that there were no "really serious cases resulting from the effect of possible toxic gases" we are quite willing to accept their verdict.

As a byproduct of the incident we were led to investigate the general use of Pyrene and other forms of carbon tetrachloride fire extinguishers. The results show conclusively that, owing to its poisonous properties, great care should be exercised in its use, since illness and even death may result under some conditions. We are also convinced that, in offering for sale a chemical product of this kind, the manufacturers are in duty bound to protect the public against the consequences of unintelligent use.

We acknowledge error in our interpretation of the subway accident, but feel justified in maintaining the general principles here expressed.

Current Investigations On Fatigue of Metals

ABOUT three years ago a notable investigation into the endurance of metal under rapidly alternating stresses was started by Prof. H. F. MOORE. An enormous amount of work has since been done on a group of steels, some fundamental information of extreme practical value discovered, and at a very low cost—in fact, it amounts to less than one cent on every ton of alloy steel produced during the period. It would be ridiculous to assert that the makers and users of fine steels have not profited to that extent. As a matter of fact, they have gone untaxed, since the cost has been borne by the Engineering Foundation, the General Electric Co. and the University of Illinois.

Within a few weeks the original program will have been completed.

It has established high probability to the belief that metal has a true endurance limit—that is, a unit stress which no matter how often repeated can be successfully resisted. Fortunately for the testing engineer, a slightly higher stress causes failure in less than ten million repetitions, so that these time-consuming tests can then be discontinued.

The investigators have also determined that a very close approximation to the endurance limit may be had by measuring the heat generated in a loaded beam, rapidly rotating, and have devised a simple machine for this purpose. Such a test takes as many hours as formerly required weeks or even months.

An idea of the endurance of a tough steel may even more rapidly be had by assuming it to be 45 per cent of the ultimate tensile strength or 250 times the Brinell hardness.

Designers, manufacturers and users of turbines, high-speed engines, axles or springs will not now have to rely upon factors of safety, or rather factors of ignorance, ranging up to 20. Of course, ripe experience and service records are the ultimate judges of excellence, but such judgments may not be had rapidly. Actual tests are continually needed to pick out the best material from several attractive analyses or heat-treatments. Furthermore, manufacturers of such things as cast steel, drop forgings, wrought aluminum or manganese bronzes and malleable iron are often called upon to make pieces which are subject to alternating stresses. How much do they know about the fitness of the material they furnish for that particular duty? In nearly every case it is less than nothing.

Ultimately, a great many plant laboratories will be equipped with facilities for conducting endurance tests. Purchasers will demand it. But these will require no little money and competent supervision, both of which seem to be rare just now. At the present moment such work can be submitted to Professor MOORE's department at the University of Illinois and be handled by an experienced test party. It is estimated that reasonably complete data on one lot of metal can be had at a cost of not more than \$600—certainly a modest sum compared to the damage resulting from one disastrous failure or, for that matter, to the money already expended by more than one progressive concern in its own laboratory, studying fatigue.

The pioneering work has already been done. American industry doubtless will recognize the economy in making best use of this organization—it can skim the cream, as it were!

Readers' Views and Comments

Impressions Concerning the European Steel Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—The outstanding impression one receives from a rather extended tour of the north European countries is that business conditions, particularly in iron and steel, are extremely unsettled, and there is a great deal of unemployment.

The output of pig iron in England has increased over 1921 figures, but is still less than half 1919 and 1920 figures. The 1922 output of steel ingots and castings has averaged around 400,000 long tons per month; the average for 1919 was around 700,000, and over 800,000 in 1920. In June, 1922, 115 blast furnaces were operating, against 298 for June, 1920. In June, 1922, 212 open-hearth plants were operating and 497 in June, 1920. Average weekly wages of iron and steel workers are lower now than any time since 1914. The official figure for June, 1922, was £2/16/0 (\$12.30) per week, against \$22 in June, 1919, and \$8.25 in 1913.

Taxes are extremely high in England, many employees and salaried men paying up to 60 per cent of their total income in taxes. This high taxation is blamed for the present stagnation in British industries—the employer will not risk capital or engage in new enterprises and most of them are just waiting for sane business legislation and reasonable taxation.

As is doubtless well known, the British Government has a system of unemployment insurance doles and probably one-quarter of the whole working population is in receipt of these weekly payments. It was stated by the lately deposed government officials that such payments for unemployed were necessary to prevent, possibly, a revolution, but the result has been extremely bad. The worker draws sufficient to keep himself comfortably without working and does not appear anxious to work and earn a somewhat better wage. The employer of labor feels he is unfairly taxed to keep idle these drones and he has no incentive to find more work. He knows the British workmen are too sensible to be gulled by "revolution" talk, but all the same they will take money without working just as long as the government is fool enough to pay. In addition to the unemployed drawing government "doles" there are larger numbers of unemployed not on "dole" who are affected indirectly by the shortage of work in the main industries such as steel, coal and shipbuilding. Co-operative effort by workers and employees, as understood here, is practically unknown and the future looks very dark for many British industries.

The Welsh tin plate mills appear to be the only works running on anything like normal capacity—their output is quite up to previous good years.

From a short visit to France it would appear that there is much less unemployment than in England. A great deal of building and reconstruction work is going on, particularly on the old battle areas. To the writer the one outstanding feature of France was the amount of ground that is being put into cultivation. Contempt and hatred of Germany are still much in evidence but not interfering with their getting down to real work.

Norway appears to be in a transition stage between war profits and after-war losses. Their experiments with prohibition were quite farcical. They prohibited wines, so the Spanish and Portuguese prohibited Norwegian dried fish and sardines, practically closing down the Norwegian fishing industry. Then the Norwegian Government permitted light wines and beers and agreed to take the Spanish and Portuguese wine crop in return for the lifting of the embargo on fish.

Just a little example of too much independence!

American products are in considerable demand in Scandinavia, but the unfavorable rate of exchange is preventing much business in American material. The Fordney tariff has created a very unfavorable impression abroad, particularly in those countries which are large debtors to the United States. The fear is openly expressed that they will be unable to meet these debts until the tariff wall is removed and reasonable trade facilities are given. It is the only way some of these countries can pay, and if we stop trade we stop payments also.

FRANK HODSON.

Electric Furnace Construction Co.,
Philadelphia, Pa.

Galvanic Corrosion on Yacht Sea Call

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the Oct. 4 number of *Chemical & Metallurgical Engineering*, page 678, and referring to Montreal meeting of the American Electrochemical Society Henry Howard of Cleveland, Ohio, refers to the disintegration of the Monel yacht Sea Call. Mr. McKay of the International Nickel Co. explained this by pointing out that it was a case of electrolytic action—the stem and stern of the yacht and likewise the rivets and bolts were made of iron.

The general understanding is that the Monel metal showed evidences of depreciation, and *not the iron parts*. As Monel metal is quite strongly electronegative to both cast and wrought iron as well as steel in an electrolyte of sodium chloride solution, the disintegration referred to can scarcely be attributed to electrolytic action.

It will be interesting to hear what Mr. McKay has to say in regard to this.

A. HOUGH.

Summit, N. J.

To the Editor of Chemical & Metallurgical Engineering

SIR:—If Mr. Hough will refer to the *Engineering News* of Sept. 9, 1915, and to the *Metal Industry* for November, 1915, he will find the question of the yacht Sea Call fully described by men who made a personal examination of the yacht after she was taken out of the water. These reports show clearly that, contrary to Mr. Hough's understanding of the situation, the iron and steel showed depreciation, and *not the Monel metal parts*. I agree with Mr. Hough that Monel metal is strongly electronegative to iron in sodium chloride solution. In such a cell Monel metal will be the negative pole and the current in the solution will flow from the iron electrode to that of Monel metal, disintegrating the iron and protecting the Monel metal, which explains the disintegration referred to, contrary to the conclusion drawn by Mr. Hough.

ROBERT J. MCKAY.

New York City.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, Oct. 21, 1922.

THERE has been a marked improvement in the chemical trade, particularly in heavy chemicals, although there are few changes in price to record. The policy of buying from hand to mouth which has been pursued for so long has probably spent itself and in the near future purchases should be on a larger scale. The recent spectacular rise by which the price of rubber has been doubled is only partly due to the decision to restrict output; similarly, when buyers come forward with more substantial orders, those who have held off too long may also find themselves at a grave disadvantage in regard to certain chemical commodities. The present political upheaval has, if anything, been a bull point, as the policy which a Conservative Government is likely to pursue should benefit British chemical industries at the expense of foreign competitors. This does not necessarily mean that there would be additional tariff legislation and the program would not be influenced materially by the Fordney tariff, the effect of which has already been discounted to some extent, although its precise consequences are not yet clearly realized.

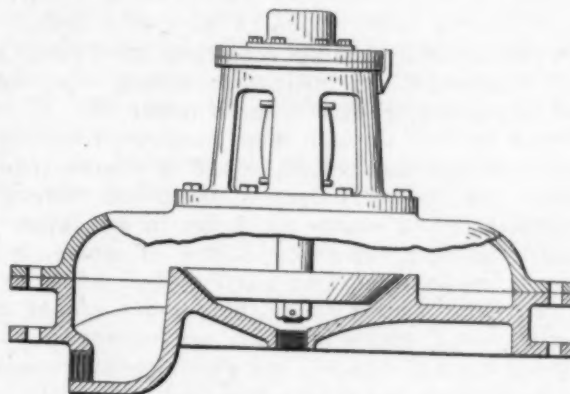
A BRITISH MILL FOR EMULSIFICATION AND DISINTEGRATION

Several articles have recently appeared in the technical press descriptive of the Plauson colloid mill. The Plauson Research Institute has taken out hundreds of patents in connection with the possible application of the principles on which the invention is based, and it would seem that many of the claims formulated are rather in the nature of intelligent anticipation, with actual practical results to follow. Much play has been made with the word colloid, which perhaps may be likened to the diagnosis of "gout" when the routine medico does not quite know what ails his patient. It is therefore refreshing to find a British mill put on the market by the Premier Filterpress Co. working on an entirely different principle, apparently achieving at least equal results and perhaps studiously refraining from the use of the word colloid. The Plauson mill works on the impact principle, while the Premier mill depends on a shearing action in liquid suspension. The subject seems of sufficient importance to give a short description in these notes.

DESIGN OF PREMIER MILL AND ITS APPLICATION

Reference to the diagram shows that the mill comprises a conical rotor revolving vertically at 1,000 to 5,000 r.p.m. in very close proximity to a corresponding machined conical surface in the outer casing, the materials to be treated passing upward between the two surfaces and the whole arrangement bearing a close resemblance to an automobile clutch. The gap between the two surfaces is adjustable by means of a micrometer head and in practice the clearance may be anything between 0.003 and 0.025 in., according to the nature of the work being done, without ever permitting the two surfaces to touch. When the mill is working, the material is pumped through in liquid suspension at a suitable rate and, owing to the enormous speed of the rotor, the suspended particles are rapidly torn apart in the passage of the fine film between the conical surfaces. As there are no grinding surfaces, wear and tear are prac-

tically eliminated and the power required for the mill itself varies between 2 and 5 hp. when treating 5 to 10 gal. per minute of oils or milk. In practice two liquids normally immiscible become so finely divided that they coalesce and form an emulsion, while solid particles are very minutely disintegrated, the machine being jacketed



THE PREMIER MILL

if necessary, for heating or cooling during operation. As instances of successful application, the regeneration of milk from the dried powder, the manufacture of vanishing cream using about 10 per cent of magnesia, the grinding of ferric oxide and the mixing and incorporation of all kinds of paints, varnishes, enamels, disinfectants, etc., may be mentioned, and the purification of naphthalene, benzene, etc., is also facilitated. Experimental work is continuously being carried out in regard to further new applications, two mills having been installed for that purpose and, as is usual, many initial failures have subsequently developed into real successes by the use of small quantities of additional reagents and by suitable modifications of clearances and other working conditions.

THERE IS LIME AND LIME

Old Buxton lime has held the field for so long that the advent of a serious competitor entailed extensive propaganda. Now that Callow rock lime is making progress we are in the midst of antagonistic advertising by the rival producers on ingenious and even ingenuous lines that remind one of the salesman's comparison between lubricating oils having spherical and triangular molecules respectively. Both firms claim greater chemical reactivity for their product, the Callow interests basing their statements partly on scientific control of the burning operation and on fineness and purity, while the Buxton firms rely largely on reputation and some indefinable "natural properties" possessed by their raw material. Good chemical lime is of considerable importance in the manufacture of bleach and for the alkali, paper, textile, ammonia and other industries, and the booklet issued by the Callow company is instructive in spite of its quite natural bias. Reactivity is presumed to be measured by the rate of reaction with water, and both firms claim that a ton of their lime will go further than a ton of "any other lime." The lesson to be drawn seems that just as for feldspar, standard tests and specifications are needed and also the publication of comparative test results under reliable expert supervision for each particular application in the chemical industry. The fact is that competition has made the producer realize that lime is really a chemical and cannot be placed in the same category as common brick.

European Conditions as I Saw Them*

Comparative Fundamental Conditions in France, Belgium and Germany
—Grievances of France as to Her Monetary Status—Analysis of
the French Coal Situation, Showing That There Is No Foundation
for the German Bitter Complaints Against France's Coal Policy

BY J. S. NEGRU

COMPARING existing conditions in France and Belgium, I am inclined to believe that, taken altogether, France is much better off.

During my trip through these countries I learned of some conditions that are far worse in France than in Belgium, but, in my judgment, these are more than counterbalanced by others which are in her favor. In the unfavorable group of conditions, of course, is the enormous loss in life and devastation of property during the war. But among those things that are of first importance in France's favor are the following:

France is and always will be a self-supporting country, whereas Belgium has always depended and will have to depend on imports for the daily necessities of life and for the raw materials needed to support her old-established industries, such as iron, zinc and glass. France can readily find markets for her products at home, as well as in her extensive colonies, besides being well assured of a large export of goods in the luxury class to practically all the countries of the world. Belgium, on the contrary, can scarcely find markets at home for her products, while her only colony, the Belgian Congo, does not yet absorb appreciable quantities of manufactured goods. As for foreign markets, Belgium has to contend with strong competition from surrounding industrial countries, and this is not lightened by the fact that she must import so much of her raw material.

The great losses of France may be classed as temporary. It may safely be expected that within a very few years she can be reconstructed in population, if I may use such an expression, as well as in devastated property. Her inherent advantages are stable. Belgium, on the contrary, is and will be for a long time to come at the mercy of outside factors that will determine whether she can regain and hold her absolutely necessary foreign market.

These, briefly, are my reasons for saying that, taken altogether, France is much better off than Belgium.

DISTINCTIVE CHARACTERISTICS BETWEEN FRANCE AND GERMANY

In comparing conditions in France and in Germany, I am led to set down two main points that appeal to me as the fundamental reasons why France is in a far better position than Germany.

First, France has proved in the past that she can be a good loser, and as such, has enjoyed deserved consideration at the hands of the other nations. Everything points to the fact that Germany, too much imbued with a sense of her own importance, was unable to accept the consequences of the war, however hard they may have been, with the result that she is gradually becoming the ward of others.

Second, France is an entity, whereas Germany is merely an artificial aggregation of peoples who have only the language in common. As a result, France was

and is one in adversity as well as in prosperity, whereas Germany seems to be on the road to disintegration at the first appearance of adversity.

To the foregoing also may be added the fact that the French demanded *revanche* (revenge) in all that the word implies, and took it as the best guide of their thoughts and actions. The Germans, on the contrary, are apparently dominated by a spirit of *Hass* (hatred). Revenge breeds a will to regain superiority by reasoned deeds, however wrong the reasoning may be; hate breeds bad blood, a kind of animal savagery that prevents clear thinking. "Ich hasse Wilson und mit die Franzosen kein Mitleid" (I hate Wilson and have no pity for the French) was the parting statement given me by Dr. von H. In view of all that is now being written in Germany on the psychology of this and that, it would seem to be timely for them to consider the comparative psychology of revenge and hatred as applied to co-operation among neighboring countries.

GRIEVANCES OF FRANCE AS TO HER MONETARY STATUS

I had not been long in France before I discovered what one would naturally expect—namely, the grievance of France as to her monetary status. The official figure for reparation expenditures in the devastated regions was put at a little over 80 billion francs in March, 1922. Part of this was advanced by the French Government in monthly installments up to February, 1921, and the remainder was obtained from the sale of shares offered by the devastated industries. Not one pfennig had been paid by Germany for reparation up to March, 1922. Such a statement, coming from many sources, and especially from E. Gruner, vice-president of the Comité Central des Houillères de France (Central Committee of French Collieries), was quite evidently a fit subject for conversation with representative Germans. As a consequence, I learned later that although large sums had already been paid by Germany, they had not in the least been used for reparation purposes, but had been expended on the different commissions with their large number of experts and for the maintenance of allied soldiers in Germany.

It is idle for me to pass judgment on the advisability or necessity of having so many allied soldiers in Germany, but with respect to the numerous commissions and their experts I may say that the impression I got of their work is that they are like buckets with screen bottoms, through which huge sums have been poured that might have been used to better advantage.

Another monetary difficulty in France is a consequence of the failure of the Russian Government. Before the war over 20 billion gold francs was invested by the French people in Russian industries, and this sum now looks to be a total loss.

It is not difficult to see, therefore, that the failure

*This is the fourth of a series of articles by Mr. Negru on this subject. The first appeared in the Oct. 18 issue, the second in the Oct. 25 issue, the third in the Nov. 8 issue.

*From de C. in France I learned that a very good engineer of "Postes et Télégraphes" was a coal expert in Germany, and on one occasion I dined with a Belgian expert who gave small evidence of fitness for his position.

of both debtors, Germany and Russia, to meet the claims of the French people and the accumulation of huge debts contracted for carrying on the bitter struggle of war are weighing heavily on the French people, and explain somewhat the stand France is taking.⁵

GERMANY'S BITTER COMPLAINT AGAINST THE FRENCH COAL POLICY UNFOUNDED

Germany is making a capital case of her coal situation, and bitter complaints are being made by the intellectuals, as well as the common people, that France is squeezing her out of the much-needed coal which is then used for export purposes. From what I learned I know that this accusation is not warranted but that it is used with great efficacy to keep alive the deep hatred of the German people against the French. I openly expressed this opinion and recorded it in my diary as late as March, 1922, and I shall now endeavor to substantiate it.

According to the stipulations of the peace treaty, it is known that the Saar district is to be worked for a limited number of years by the French as compensation for the devastated French coal mines and that Germany will have to export to France certain tonnages of coal on account of reparations.

Lately Germany has also lost part of the Upper Silesia coal fields. Circumstances did not permit my getting from both sides any impressions about the Upper Silesia coal, so I shall content myself by expressing my personal opinion, gathered in casual conversation, that this loss is more on paper than in reality. Apparently, little of the Upper Silesian coal has been used outside of what is now the lost district. But as this is merely a personal impression, I prefer not to consider it particularly, and I shall dwell only on what I learned from both sides regarding the Saar district and about the export to France.

GERMAN OFFICIAL COAL FIGURES

Although I am in possession of data and figures gathered during my trip, I shall use instead those presented in an official document of the German Government that came into my possession lately—namely, the "Bericht des Reichskohlenrates über die Kohlenwirtschaft im Jahre 1921," (Situation of the German coal industry in 1921), trusting that conclusions derived from this document will carry more weight.⁶

In 1913, the production of the Saar district was 13,071,000 tons of coal, and that of the Pfalz and Lorraine districts was 4,790,000 tons, respectively 6.8 and 2.5 per cent of the total German coal production for that year. These districts, which in 1913 had a total production of 17,861,000 tons, or 9.3 per cent of the total German coal production, are now in French hands. During the same year the production of coal in what is now the French devastated region was 18,662,000 tons.

In 1921, the Saar, Pfalz and Lorraine districts pro-

⁵In confirmation of these impressions that I gained in April, I may cite the following enumeration of conditions by Lord Henry Bentinek, published in the London Times for Aug. 1, 1922:

"1. Great Britain and America together are claiming from France a far larger sum than France can ever hope to receive from Germany.

"2. While Great Britain has secured, as spoils of victory, large tracts of territory and the removal of the menace of the German navy and the competition of her commercial fleet, France has not yet received any substantial payment for the restoration of her devastated areas.

"3. While France's claim is a just one, Great Britain's claim for payment of pensions and allowances, while being of doubtful justice and questionable morality, has contributed to the present impasse by piling on Germany a burden of debt impossible to discharge."

⁶The document is dated April 1, 1922.

duced 9,574,000 tons of coal, and the French devastated district 5,365,000 tons, a total of 14,939,000 tons, as against 18,662,000 tons in 1913. Thus, France still has a deficit of 3,723,000 tons with the Saar, Pfalz and Lorraine districts included.

In 1913, the total French production was 40,278,000 tons of coal,⁷ of which 21,616,000 was in the non-devastated area. In 1921, the total production was 27,516,000 tons, of which 22,151,000 tons was in the non-devastated area. This gives an excess of 535,000 tons in 1921 over the 1913 production in the non-devastated area.

The French import and export of coal for 1913 and 1921 were as follows:

Year	Import Tons	Export Tons
1913.....	23,889,000	1,511,000
1921.....	23,132,000 ⁸	2,360,000

In 1913, the amount of coal in France was: 40,278,000 tons mined in France plus 23,889,000 tons imported minus 1,511,000 tons exported—i.e., a net total of 62,656,000 tons. In 1921, the amount of coal in France was: 22,151,000 tons mined in the non-devastated area plus 5,365,000 tons mined in the devastated area plus 9,575,000 tons from the Saar, Pfalz and Lorraine districts plus 23,132,000 tons imported minus 2,360,000 tons exported—i.e., a net total of 57,863,000 tons, as compared with the net total of 62,656,000 tons in 1913, a difference of 4,793,000 tons.⁹

These figures show clearly that the 1921 export of 849,000 tons in excess of that of 1913, the decrease in import of 757,000 tons in 1921 as compared with 1913 and the deficiency of 4,793,000 tons between the French total coal in 1913 and 1921 do not warrant in the least the bitter accusation of the Germans that their coal industry is crippled by the French, who, they contend, use all of the coal imported from Germany for export purposes only, while Germany is forced to buy English coal with her depreciated marks.

It might be well to give here additional figures showing German coal production, import and export, for 1913 and 1921:

Year	Production Tons	Import Tons	Export Tons
1913.....	209,467,000	16,257,000	45,986,000
1921.....	163,286,000 ¹⁰	3,223,000	26,903,000 ¹¹

Nor do these figures show that the German coal industry is thoroughly crippled by the French, for the import in 1921 was less than 20 per cent of that in 1913, and the reduction in the total amount of coal mined was not due solely to the loss of a maximum of 17,861,000 tons from the Saar, Pfalz and Lorraine districts (1913 production), but to the diminished working capacity of the miners. Similarly, the 26,903,000 tons export for 1921, of which less than 70 per cent goes to the Entente for war reparation, is not in the least as discouraging as the Germans make out, when compared with the export of 45,986,000 tons in 1913.

While I was still in Germany I was aware of the existence of these figures, and I used them in conversation with industrial leaders. Some of those with whom I spoke contended that quality as well as quantity of coal had to be taken into consideration. Granting this, I wish to add that, from personal experience, I know

⁷All the figures of coal tonnage refer to the sum of the separate items of coal, coke and lignite, calculated on a coal basis.

⁸This includes also the total amount imported from Germany on account of war reparations.

⁹I have learned from authoritative sources that the present French demand for coal is practically the same as before the war, even with her western industries not yet fully reconstructed.

¹⁰This does not include the Saar, Pfalz and Lorraine districts.

¹¹This includes also the total amount exported to the Entente on account of war reparations.



TRANSLATION

For the First of April

Once again has arrived the date when Otto von Bismarck was given to the German people, the man whose gigantic work the pygmies of today try systematically to destroy.

How different it would have been for Germany if the answer to the last note had been framed by the builder of the old empire, and not by Wirth and Rathenau.

"I am here to talk business, and not to discuss sentimentalities."

"I do not pretend to be an orator nor a master of oratory; I am a minister, diplomat and statesman, and I would feel injured were I to be called an orator."

"Happy are those who have lived without hatred. What a simpleton this Goethe!"

"Goethe was wrong when he stated that love alone beautifies life. Hate does the same thing. It stimulates life just as strongly as love does."

We remember you, Otto von Bismarck, with pride and deep sorrow.

that the quality of coal exported from Germany in pre-war time was the same as that of 1921.

Only those who have witnessed the exalted spirit of hatred of the Germans against the French on account of their wrong conception of the coal situation can realize how well it would be for the Germans to study the above-mentioned official German report and reason out the actual conditions. This, and similar reports, would do much to counteract and perhaps stop the hate-breeding propaganda carried on through German papers.¹²

Other articles by Mr. Negru on this subject will appear in subsequent issues.

¹²The official coal report is dated April 1. On the same date, which is the anniversary of Bismarck's birth, the Berlin weekly newspaper *Die Gesellschaft* published in heavy black letters the item reproduced herewith, the quotations being selections from Bismarck's utterances.

Russian Chemical Industries

THE FIRST nitric acid factory in Russia has recently been opened in a small town near the Black Sea. The Russian Government has offered important concessions to foreign capital for the establishment of three such factories. In the meantime Russia has gone ahead with this factory, known as the "Yousovsky," which occupies 21½ acres near the Novo-Snolianikey mine, formerly owned by the Novorossiisk company. The liquid ammonia process is used, with a platinum catalyst in the oxidation reaction. The yield is extremely satisfactory, as the following table shows. The yield at the Yousovsky factory is here compared with those of well-known foreign factories:

Process	Percentage Yield	Quality of Ammonia in Kg. Used Per Oz. of Platinum Per Day
Ostwald.....	85	14.7
Amer. Cyanamid.....	90.92	22.65
Bureau of Mines.....	90.91	27.2
Yousovsky Factory.....	93.97	17.27

PHOSPHATE WORKS IN RUSSIA

Two superphosphate works, one at Kineshma and the other at Nijni, are at present at a standstill owing to lack of capital and the necessity for re-equipment. The Briansk factory, although working, is in a not much better condition. On the other hand, the exploitation of the huge rediscovered phosphate deposits in the Province of Viatka and near Moscow has begun, but the work is still on a small scale. A proposal was made to import phosphates, but it has been decided first to investigate fully the possibility of home production. Large stocks of phosphates exist, but a market cannot be found for them owing to the high cost at which they are produced and to the low purchasing capacity of the peasants. A commission has been appointed to see whether these stocks cannot be sold (a) through a company; (b) by direct credits to the peasants; (c) by lowering the price of phosphate. If these measures are not successful, phosphates will have to be imported from abroad.

Extensive deposits of kaolin, graphite and manganese have been discovered in the Province of Odessa; work on these has already begun. Large quantities of bismuth have been discovered in the Trans-Baikal Province, on the territory of the Far Eastern Republic.

SUGAR AND SOAP INDUSTRIES

For lack of necessary and modern equipment the sugar and soap factories in Russia are operating on very low production. The price of sugar is very high. Soap sells for from two to three times the price in the United States.

SANTONINE IN TASHKENT RUSSIA

The santonine factory in Tchikment, in the Province of Tashkent, was nationalized in 1918 and placed under the control of the Supreme Council of National Economy. The latter body had the factory put into shape and operation in 1920, with the result that now 100,000 poods (3,600,000 lb.) of raw materials is worked annually and 5,000 kg. of pure santonine is produced.

The santonine plants (*Artemisia citæ*) grow in the Tashkent district of Russia. Over 1,000,000 acres are devoted to the growth of this plant. An acre yields about 60 kg. of the plant, which is brought over for processing to the Tchikment factory. Before the war, santonine was chiefly purchased from Merck in Germany.

Fireclay Refractories

Outline of Manufacturing Operations at the Laclede-Christy Clay Products Co., St. Louis—Dry Press and Stiff-Mud Process Fireclay Brick—Special Shapes—Glass House Refractories—Washed Pot Clay

BY ALAN G. WIKOFF

IT IS PROBABLE that the fireclay refractory industry in the United States dates from 1812, when a firebrick plant was erected in New Jersey, although the exact location of this first plant is uncertain. With the increasing industrial demand for materials more refractory than common brick, the industry developed rapidly, deposits of suitable clay being abundant in many localities. By 1842 the industry had progressed as far west as St. Louis, where 2 years later the Laclede Fire Brick Manufacturing Co. was established. In 1857 the Christy Fire Clay Co. was founded, and the combination of these two firms in 1907 formed the present Laclede-Christy Clay Products Co.

Owning 240 acres of clay mines right in the heart of the famous Cheltenham clay district, the company is assured of a constant supply of this essential raw material. The two main plants are located within the city limits of St. Louis, the larger of these, known as the Laclede plant, being located on Manchester Ave. south of Forest Park. The Christy plant is about 2 miles further south on Kingshighway Boulevard.

Practically every variety of fireclay article is made at these plants. The refractories line is particularly complete, including six grades of firebrick adapted to meet the different conditions of heat, abrasion and fluxing action encountered in industrial furnaces; chemical brick and acid tower packing rings; special shapes and tile for boilers, stokers and furnaces; glass house refractories. In addition clays are prepared for use in a number of other industries, such as the manufacture of glass house pots, lead pencils, crucibles, oilcloth and paper filler. Sewer tile, drain tile and related products are also made from fireclay, a considerable portion of the Laclede plant being devoted to their manufacture. The total daily capacity of the plants is 700 tons.

In spite of the great variety of products, the number of different manufacturing methods is not large, so that a rather brief outline will serve to indicate the operations at these plants.

Laclede Plant

Three plants comprise the Laclede group, numbered as follows: 1, brick and tile; 2, sewer pipe; 3, refractories.

DRY PRESS PROCESS BRICK

Two brands are made by the dry press process, the less refractory having a fusion point of Seger cone 29 plus, or about 3,100 deg. F., while the other melts at cone 32 plus, or about 3,200 deg. F. While the clay mixtures differ, the process remains the same for both grades.

Cheltenham plastic clay forms the raw material for the less refractory grade. It is brought from the mines just back of the plant on a narrow-gage high line so that the clay can be dumped through hoppers into storage bins. When ready for use, the clay is shoveled into a measuring car having adjustable vertical partitions which determine the proportions of raw and burnt clay, or grog, in the mixture. The mix is dropped through a chute onto an apron feeder which supplies a

conveyor running to the dry pans, where the material is ground. It is then transferred to storage bins on an upper floor by means of a bucket elevator.

Mixtures for the more highly refractory grade contain, in addition to the plastic clay, raw and burnt semi-flint clay from mines owned by the company in northern Missouri.

Chutes from the storage bins deliver into agitators which are simply cylindrical wooden tanks provided with a mechanical stirring device. These serve to maintain a steady flow of material to the three Boyd dry presses on the floor below. The tremendous pressure applied forms brick so firm that they will stand almost any amount of handling, even before drying.

WASTE HEAT DRIERS

For drying, the brick are carefully arranged on double deck cars holding about 540 9-in. brick. The driers consist of a series of parallel tunnels through which the cars are pulled by an electric crab. The motion is not continuous, as the cars must remain in the drier for about 2 days. At regular intervals cars of dried brick are drawn, a corresponding number of cars of green brick being run in at the other side of the tunnel so that it is always full.

Heat from kilns which are cooling is supplied to the driers by a powerful blower so as to maintain a temperature of about 210 deg. F. at the exit end. A Bristol recording thermometer gives a permanent record of drier conditions. Every 2 months anemometer readings are taken to make sure that the flues leading from the kilns to the driers are open and free from obstruction.

There is a space in front of the driers so that the brick can cool off before going into the kiln. In case no kiln is ready the cars can still be drawn on schedule and held there. Fig. 1 shows several cars of brick ready for the kiln and also the electric crab which is used to pull the cars. This runs on a track laid at right angles to the drier tracks. Transfer cars also use this track in distributing cars of brick to the tracks in the kiln yard.

At first sight it would seem possible to conserve heat by transferring the brick immediately from the driers to the kilns, but as the brick must be set by hand, they would be too hot to handle. Further, about 2 days is

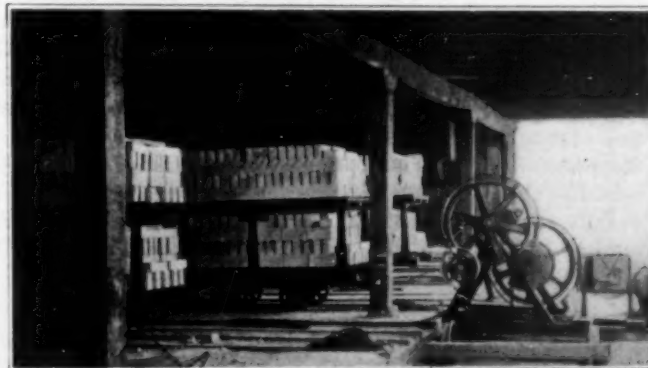


FIG. 1—DISCHARGE END OF DRIERS



FIG. 2—SETTING RECTANGULAR KILN

required to set a kiln, so that most of the heat would be lost anyway before the kiln could be fired.

BURNING

Refractories are all burned at this plant in down-draft periodic kilns of either the round or rectangular type, there being seventeen kilns at the brick and tile plant and nine at the refractories plant. The capacity varies from 240 to 350 tons. As a 9-in. brick weighs about 7 lb., the latter figure is equivalent to about 100,000 9-in. brick.

In setting a kiln, unnecessary handling is eliminated by running the cars of dried brick right into the kiln, as shown in Fig. 2, which also illustrates the method of setting a rectangular kiln. Brick in the lower part of the setting are arranged according to a definite plan which will give the most uniform burn throughout the kiln. Tile and special shapes are placed in the upper part.

The burning schedule is followed by the indications of a Price pyrometer. A recording instrument of the same make serves as a check on the burners and also gives a permanent record. Kilns are finished at about 2,350 deg. F., the exact time being determined by drawing trial pieces from the kiln and observing Seger cones.

Kiln turnover is from 14 to 16 days, as follows: Setting, 2; burning, 5 to 6; cooling, 5 to 6; drawing, 2.

STIFF MUD PROCESS BRICK

As in the case of the process just described, two brands are made by the stiff mud process. Here again the only difference is in the composition of the mixtures, the more refractory grade containing flint clay as well as plastic clay.

Ground mixtures are fed from the storage bins to a poidometer which controls the delivery of clay and water to a pug mill in the exact proportions necessary to form a mud of the desired consistency. The clay is then worked in a vertical auger machine, discharging in the form of a continuous column from which the brick are formed by a wire cutter. The rough brick are then put through represses to insure true dimensions and a clean-cut finish. The brand is also stamped into the brick during this operation.

Subsequent operations of drying and burning are similar to those for dry press brick.

SPECIAL SHAPES

Of particular interest is the recent development of machine molding for certain special shapes which have hitherto been molded by hand. Of necessity the designs must be small, fairly simple and in sufficient demand to

warrant the expense of preparing special dies. Pouring nozzles for use in steel mills are being made this way successfully.

Mixtures for special shapes are brought to a workable consistency with water in an auger machine, the proportions of water and clay being regulated by a poidometer. Numerous mixes have been developed to meet the conditions to which a particular shape will be subjected in service. Whenever possible wooden molds are used and the pieces are set on steam-heated wooden drying floors until ready to go to the kiln. Their disposition in the kiln has already been indicated.

Christy Plant

While brick are also made at the Christy plant, the processes are so similar to those already outlined that further consideration is unnecessary. Features of particular interest at this plant are the manufacture of glass house refractories, preparation of clays for special uses, and the ceramic laboratory. Fig. 3 is a general view of this plant.

GLASS HOUSE REFRACTORIES

Owing to the unusually severe service conditions, the manufacture of refractories for use in the glass industry presents many difficult problems. For example, modern continuous tanks are operated at about 1,510 deg. C., or 2,750 deg. F., and the refractory blocks which form the bottom and sides of such furnaces must resist the fluxing and wearing action of molten glass at this temperature. In addition, the blocks must not check or crack with changes in temperature and should be good non-conductors of heat. The requirements for glass pots are even more exacting. The Cheltenham deposit is one of a very few in the United States which yields clay suitable for these purposes.

Tank blocks are carried in stock in sizes varying from 12x12x18 in. to 12x24x36 in., and the care which must be exercised to obtain uniformity of composition, drying and burning in pieces of such size can readily be appreciated.

Pot clay purified by washing is used in the preparation of tank blocks of the flux grade, the grain size and proportion of raw to burnt clay being carefully adjusted to give the desired properties to the finished block. The mixture is tempered with water in wet pans to the proper consistency, aged, pugged and worked into the molds by hand. The blocks are permitted to dry on the floor very slowly in order to prevent cracking. After drying, the blocks are trued by the action of emery wheels in a machine made by the Niles Tool Machinery Co. The emery wheels themselves wear very rapidly and have to be trued about once a day.

The blocks are burned in round down-draft periodic

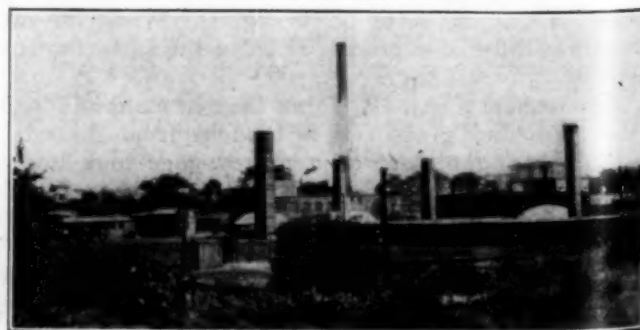


FIG. 3—GENERAL VIEW OF CHRISTY PLANT

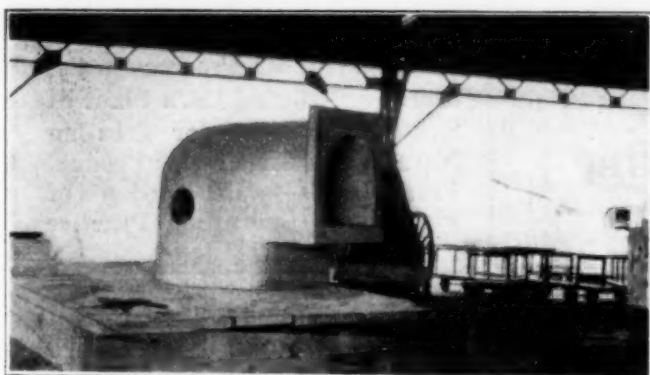


FIG. 4—BOOT FOR GLASS FURNACE

kilns, the blocks being set in the center surrounded by a 3-ft. ring of washed clay blocks.

Many other interesting shapes are made for the glass industry, such as gathering rings 4 ft. in diameter, floater legs up to 8 ft. in length and boots as shown in Fig. 4. Nor are the products of this plant limited entirely to glass house materials. Figs. 5 and 6 are typical of the wide range of complicated shapes. The latter is particularly interesting because of the core which in the finished block passes completely around the central circular opening. The photograph shows only the right-hand portion of a complete block split through the center.

WASHED POT CLAY

The use of washed pot clay in the manufacture of tank blocks has already been referred to. This is also prepared for sale in various forms. In wooden tanks provided with agitators, a slip is prepared by beating up selected pot clay with water. The slip passes through a screen into a trough which leads from the five agitators to six wooden settling tanks. The trough has a chain drag conveyor to prevent settling in transit. After the clay has settled in the tanks, the clean water is drawn off and the thick clay soup pumped through a battery of eight Johnson filter presses. These have a capacity of 15 tons of clay and it is possible to fill them four times per day, giving a daily capacity of 60 tons. The cakes are dumped to a conveyor which feeds a pug mill. The washed clay emerges from this in the form of a continuous column which is cut up into blocks weighing about 23 lb. when dry. Some of the blocks are calcined and ground to form grog. The clay may be sold as blocks or ground, either dried or calcined according to the requirements of the purchaser.

BAGGING CLAYS

Many of the prepared clays are shipped in a finely ground state. The material is fed through an automatic



FIG. 5—TYPICAL SPECIAL SHAPE

weighing hopper into bags which pass on a very short conveyor belt to a stitching machine made by the Union Special Machine Co. The bags proceed on a gravity roller conveyor to another conveyor which delivers them right to the car. One man at the machine and one man at the car can handle 2,000 100-lb. sacks of clay per day in this way.

CERAMIC LABORATORY

The laboratory is located at the Christy plant but it serves Laclede plant as well. It is up to date in every respect and is a vital department of this company. Here experiments are conducted for developing new mixtures and products for almost every conceivable refractory use.

In addition to new work, a careful check is kept on the standards of quality of each product. This entails periodical control tests. The various products and mixes have been developed to meet particular requirements and it is to assure the necessary characteristics of each that the control tests are made. The most important of these are: chemical analysis (ratio of silica-alumina content to flux); spalling (action under sudden

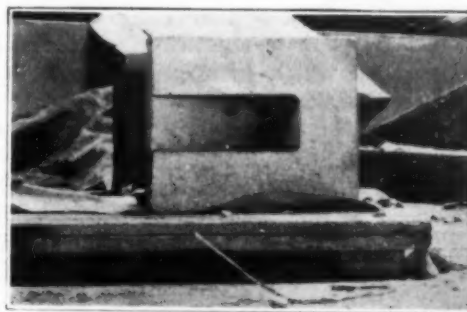


FIG. 6—COMPLICATED SHAPE WITH CORE

changes of temperature); fusion or melting point; reheat (linear changes after having been fired at high temperatures); load (compression under load at high temperature); resistance to slagging action.

For assistance in obtaining data for this article, the writer is particularly indebted to Richard D. Hatton, vice-president and general manager, W. F. Godejohn, industrial engineer, and John B. Lyons, superintendent of the Christy plant.

The Ural Platinum Mines

The provisioning and financial condition of the Ural platinum mines have considerably improved since the end of July, which in turn favorably affected production. Up to July 1 production was considerably below the program, whereas the July program was exceeded by about 30 per cent. The estimated output of private prospectors was realized only to the extent of 28.45 per cent up to July 1, due to shortage of supplies for paying the prospectors, which was also the cause of thefts of metal. The mines are provided with fuel to the end of the fiscal year.

The output of platinum and the incidental production of gold in all the Ural mines from Jan. 1 to July 15 amounted to 700 lb. of the former and 158 lb. of the latter metal; also 111 grains of iridium were recovered. Apart from this, 87 lb. of platinum was purchased from outsiders.

Use of Bleaching Powder for Sweetening Gasoline

BY H. W. YOUNG* AND A. W. PEAKE†

Development of Process at the Midwest Refining Co.'s Plant at Salt Creek, Wyo., for Treating Natural Gas Gasoline or Product From Stills — Description of Plant and Operating Practice

GASOLINE is considered sweet or sour, depending on whether it is negative or positive to the doctor test.¹ A positive doctor test indicates the presence of sulphur compounds which may be objectionable in themselves, or may, in decomposing, impart to the gasoline certain undesirable properties. The principal claim to superiority for sweet gasoline is that it is more stable in storage, showing less tendency toward the development of a yellow color and an objectionable odor.

During, and for some time following, the world war, the demand for gasoline was so great that much was marketed which would not now pass inspection. With the return of conditions more nearly approaching normal, competition among marketing concerns again became a factor. This competition led to a demand for sweet gasoline which increased to such a degree that many marketing companies would not accept sour gasoline from the refiners. In the spring of 1921 the sales department of the Midwest Refining Co. issued instructions that it would be necessary to sweeten the blend produced at the Salt Creek gasoline plant, a natural gas gasoline plant owned by that company and located in the Salt Creek Oil Field, Natrona County, Wyoming.

USUAL METHODS OF SWEETENING

In order to bring out more clearly the difficulties involved in meeting this situation, a review of the established methods of sweetening gasoline and of the conditions surrounding the production and shipping of the blend is presented.

The usual methods of sweetening involve the use of sulphuric acid, caustic soda, litharge and sulphur. Local conditions frequently render the use of certain of the reagents unnecessary. The application of doctor solution discolors the gasoline. This discoloration may be removed in part by a water wash, but usually sulphur is added, followed by a water wash. An immense volume of water is ordinarily used.

Natural gas gasoline is produced at the Salt Creek plant by the compression method. This is blended in about a 50:50 ratio with naphtha topped from crude petroleum at the plant. The blend is weathered to the desired vapor pressure then pumped to the refinery at Casper, 42 miles away.

The local supply of water in the Salt Creek field is an uncertain quantity. During times of protracted drought—a not unusual condition in central Wyoming—very little, if any, water can be drawn from the gravels in the creek beds. The supply from wells is inadequate and water pumped from the North Platte River at Casper is too expensive for use in large quantities.

Three conditions made the usual methods of sweetening unsuitable for use at Salt Creek:

- (1) The water supply was inadequate to permit sufficient washing of the treated blend.
- (2) The high initial cost of such a plant coupled with the high cost of attendance and of transportation of supplies.
- (3) Steam stilling the treated blend to remove off color would involve heavy expense for equipment and would be a serious drain on the already meager water supply.

It was imperative therefore to develop, if possible, an inexpensive method which would not discolor the blend and which would involve a minimum of washing.

PRELIMINARY TESTS

In view of the fact that sourness is ordinarily attributed to the presence of certain easily decomposable sulphur compounds, the problem naturally resolved itself into two lines of investigation:

- (1) The precipitation and removal of the sulphur as insoluble sulphide.
- (2) The oxidation of the sulphur to a more stable form.

A series of tests was made with reagents, which, in the presence of soluble sulphides, form insoluble sulphides. Ferrous sulphate did not prove of any benefit whatever. Copper sulphate sweetened momentarily, but was of no permanent benefit. Soluble salts of silver sweetened permanently, as did also mercury and mercuric oxide. This is strong evidence that the sulphur is in the form of mercaptans. Additional proof of this view was developed in later investigations.

While the results recorded above were interesting from a scientific standpoint, they were of no practical value. The first oxidizing substance used was bromine water, which proved an excellent sweetening agent. Iodine likewise gave good results. Freshly prepared chlorine water proved excellent for the purpose. The high cost of bromine and iodine prohibited their use on a commercial scale, but it was certain that chlorine could be obtained at a reasonably low cost. The blend was not discolored during treatment and was practically freed from chlorine and chlorides by relatively little washing. To sum up, the work to this time had disclosed the essentials of a process which apparently met all requirements for use under local conditions.

However, since chlorine is an extremely active element, there naturally arose a question as to the possibility of reactions between it and the liquid hydrocarbons during treatment. Such reactions would increase unduly the consumption of chlorine and might yield products deleterious to the blend.

The literature relative to the formation of substitution products by reaction of chlorine with liquid paraffine hydrocarbons is meager and conflicting. In general it may be said that these reactions are favored by high temperature, light and catalytic agents. Since the

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†Chief engineer of field division, Midwest Refining Co., Casper, Wyo.

¹Tech. Paper 214, U. S. Bureau of Mines, covers all details of the doctor test.

proposed treatment would take place at low temperature, in the dark and with no catalytic agent present, it was considered unlikely that such reactions would occur.

Hydrocarbons of the olefine and acetylene series react readily with chlorine, forming addition products. The low consumption of chlorine indicated that hydrocarbons of these types were either absent from the blend or present only in very small amounts.

Chlorine contained in steel cylinders could scarcely be considered on account of high transportation costs. It was thought that by electrolyzing a solution of sodium chloride in a suitably designed cell chlorine could be produced rather cheaply. In addition, if desired, the chlorine could be absorbed in the caustic solution produced in the cell, forming sodium hypochlorite. This would make possible the use of an alkaline solution which would considerably reduce the outlay for specially constructed equipment.

Dr. Loy, chief chemist of the Midwest Refinery at Casper, suggested the use of bleaching powder as a substitute for chlorine or sodium hypochlorite. Bottle tests proved this a good sweetening agent.

SMALL-SCALE PLANT

A small-scale plant was built to determine as nearly as possible the conditions under which plant operation should be conducted. Two 5-ft. towers made from 6-in. pipe were about half filled with broken sewer tile, which served as baffling. The first tower was filled to about two-thirds capacity with a solution of bleaching powder in water, the second was filled to like capacity with water. The blend, weathered to about 35 lb. vapor pressure, was introduced at the bottom of the treating tower, passed upward through the solution to the top of this tower, then downward through a small pipe to the bottom of the washing tower. It passed upward through the wash water, then to a storage tower, where it was measured. The pressure drop in the treating system was kept as small as possible. In all tests made with this equipment $\frac{1}{2}$ lb. of bleaching powder was used.

Several tests were made with the apparatus as described, in each of which $\frac{1}{2}$ lb. of powder sweetened about 100 gal. of blend. This was considerably below the efficiency which bottle tests had shown should be obtained. It was decided to try the effect of aerating the solution. A small tower was connected with the bottom of the treating tower, with connections so arranged that a portion of the solution could be drawn off and aerated, then returned by air pressure to the tower. Several tests were made in which, by repeated aeration of solution, each half pound of powder sweetened about 166 gal. of blend.

Tests made on the spent solution showed that considerable available chlorine still remained. There seemed to be a minimum strength of solution below which sweetening would not take place in this apparatus. A second half pound was added to the spent solution and the test repeated, the volume sweetened being 225 gal. A third test gave results checking the second. This test was repeated a number of times, and in every case $\frac{1}{2}$ lb. of powder, with an available chlorine content of about 30 per cent, sweetened 225 gal. of blend. This is at the rate of 2.22 lb. per 1,000 gal., or 0.0933 lb. per barrel.

These results were considered sufficiently encouraging to warrant proceeding with the design and construction of a plant capable of treating the entire volume of blend being produced.

Tests made on the spent solution revealed the presence of sulphate. In one bottle test and one test with the small-scale plant, distilled water was used in making up the solution and the sulphate determined by precipitation with barium chloride. The weight of sulphur oxidized to the sulphate condition per 1,000 gal. of blend treated was found in each test to be 2 grams.

Frequent mention is made in the patent literature of the use of chlorine and hypochlorites for decolorizing and "purifying" petroleum products. The only specific mention so far encountered of the use of bleaching powder for sweetening gasoline is contained in the U. S. Patent 723,368. This patent was issued March 24, 1903, and expired 17 years later. Excerpts appear in "Gasoline and Other Motor Fuels," by Ellis and Meigs, p. 106 *et seq.* This book appeared several weeks after the plant at Salt Creek was placed in commission. The process described in the above-mentioned patent is unnecessarily complicated, and, so far as known, was never employed on a commercial scale.

LARGE-SCALE PLANT

Some modifications were made in the plant as originally constructed, during the first few weeks of operation. The following description applies to the plant which has been in service for about 14 months.

The building housing the treating plant is steam heated and thoroughly ventilated. This building is divided into two rooms, the pump and control room, and the treating room proper. In the treating room are five towers, placed in a row. An open top tower of 500-gal. capacity, in which the solution is aerated, is placed next to the pump room. The remaining four are, in order, for weathering, treating, washing and settling. These towers are 6 $\frac{1}{2}$ ft. in diameter and 20 ft. in height, with dished heads, designed to operate at 50 lb. pressure. These were not especially designed for the purpose, being "daily run" towers which were no longer needed. Standard wrought-iron pipe couplings were welded on for gage glass fittings, intake, discharge and such other connections as were desired.

In the pump room are located two steam-driven duplex pumps, each 5 $\frac{1}{2}$ x3 $\frac{1}{2}$ x5 in., one for circulating solution, the other for circulating wash water. There is also a box in which fresh charges of bleaching powder are dissolved; a cabinet contains all chemicals and apparatus necessary for determining the available chlorine in the solution and for making doctor tests on the treated product.

The four large towers are provided with one set of relief valves connected to a common header which carries the weathered gas from the building. As an additional precaution each tower is provided with an independent relief valve, which is set to operate at slightly higher pressure. A pressure gage board is located in the pump room and a separate pressure gage is placed on the side of each tower. Each tower is provided with a complete set of gage glasses.

The blend, received from the plant accumulators, passes through a valve into the weathering tower, where the vapor pressure is reduced to about 42 lb., which is sufficient to force the blend through the system and to storage. From the bottom of this tower the blend passes through a knothole mixer (Fig. 1) and enters the treating tower near the bottom.² The treating solution is pumped into the mixer. During the brief interval of

²This knothole mixer is extensively employed at the Midwest Refinery at Casper.

intimate contact practically all the treating takes place. The blend entering the treating tower rises through about 5 ft. of solution, then continues slowly upward to the outlet, which is about 18 in. from the top of the tower. It then passes downward through a 4-in. pipe to near the bottom of the washing tower, in which it rises through about 8 ft. of glazed tile baffling submerged in water. It continues upward to the outlet about 18 in. from the top of this tower, then downward to near the bottom of the settling tower, in which it rises to the outlet about 8 ft. from the bottom, thence to storage. Any water or emulsion which collects in this tower is drawn off.

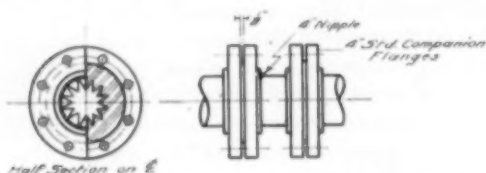


FIG. 1—DETAIL OF KNOTHOLE MIXER

The solution returning from the treating tower may be run into the 500-gal. tower, where it is aerated by splashing over a baffle, or it may be drawn directly into the pump. The latter is called the "closed circuit" plan. The average volume of solution maintained in the system is about 2,000 gal. The weight of bleaching powder in solution varies from 50 to 75 lb.

The wash water is drawn from a tank outside the building and introduced into the washing tower through two pipes which discharge it about 5 ft. below the top of the tower. The water returns to the flow tank through a pipe connected near the bottom of the tower. As the plant was originally designed the purpose of the outside tank was to provide a collecting place for emulsion and to furnish additional storage capacity for wash water. Experience has shown that little emulsion ever collects there. In cold weather it has been found more convenient to discontinue the use of this tank, the wash water being circulated on the "closed circuit" plan. Where conditions are such that it is possible to change the wash water frequently, an outside tank is quite unnecessary.

The use of baffling in the washing tower would be unnecessary if a knothole mixer were provided similar to that in the solution system. This would be cheaper, and, on the whole, more satisfactory, provided the water pump could be adjusted to handle any desired volume. If an excessive amount of water were introduced with the blend into a knothole mixer, a considerable volume would probably be carried over into the settling tower.

Solution is frequently carried over into the washing tower. The available chlorine of this solution is of course lost. If a settling tower were provided between the treating tower and washing tower this solution could be recovered.

PLANT OPERATION

When once the valves are adjusted and the speed of the pumps regulated, very little attention is required. The regular duties occupy less than one-fourth the time of one man on each shift. These duties consist of determining the strength of solution, adding fresh charges of bleaching powder, making doctor tests on the treated product and making such adjustments of valves and pumps as may be needed to care for changes in the volume treated. Repairs requiring more than a few

minutes are made by the regular repair gang in the plant. In making up fresh batches of solution the powder is drawn into the box through a chute from a drum located on a platform outside the building. The chute delivers the powder into a screen-bottomed box suspended in the upper portion of the larger box. By spraying the powder with water delivered through a hose and breaking the lumps with a shovel or hoe, it is possible to work the charge through the screen with a moderate dusting loss. The enriched solution is transferred from the mixing box to the aerating tower. The supply pipe to the mixing box is so connected that the box may be filled with fresh water, circulating wash water, or solution.

A more convenient method of putting the bleaching powder into solution is being devised. While all details have not been agreed upon, a small tube mill will probably be provided into which the powder may be drawn, water added, and the powder reduced to a fine state of subdivision. This will increase the recovery of hypochlorite somewhat, but the chief gain will be in reduced dusting loss and increased comfort to the attendant.

When the blend is excessively cold, trouble is experienced with the formation of "mush" ice in the knothole mixer and the treating tower. This trouble may be obviated by warming the solution between the pump and the knothole mixer.

Experience has shown that it is well to hold the level of the blend in the weathering tower quite low. Storage capacity to care for the accumulating blend is thus always at hand, should it be necessary to shut down the plant for a short time for repairs.

CORROSIVE ACTION OF BLEACH

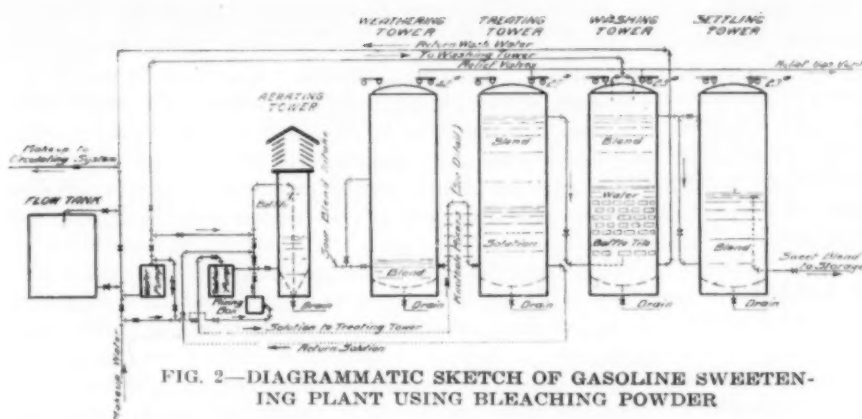
It is well known that a solution of calcium hypochlorite is corrosive to iron and brass, especially the latter. A word in regard to the effect of this solution on pumps, pipes and the interior of towers is of interest.

Until very recently the solution pump has been used to draw the enriched solution from the mixing box. A considerable amount of undissolved lumps and gritty residue was always drawn out and passed through the pump. The natural result was a rapid impairment of wearing parts, necessitating frequent replacements and repairs. The effect of corrosion was thus masked and could not be accurately estimated, but it was certain that it was small in comparison with mechanical wear.

At present the enriched solution is drawn from the mixing box into a submerged tank and elevated by gas pressure into the aerating tower. This should greatly prolong the life of the wearing parts of the solution pump. Also, tests are being made with several patent alloys with promising results to date. It is probable that the use of one or more of these for all wearing parts, in connection with relieving the pump from handling gritty residue, will solve the difficulty.

After more than 8 months of service three short lengths of pipe were removed from the solution line for inspection. One, which was in contact with a brass valve at the discharge end of the pump, was found to be badly corroded. In the others an impervious lining about one-sixteenth of an inch thick had formed, which had protected the pipe perfectly from corrosion. This lining was found to be largely calcium sulphate, with some lime.

After the plant had been in operation more than



a year the manholes near the bottom of the treating tower and washing tower were opened and the interior of these towers inspected. The interior of the treating tower was found to be covered almost completely with a coating, which, however, was not as dense nor as adherent as the coating found in the solution line. Some corrosion had occurred, but when the accumulated oxide was scraped off, the metal beneath was found to be practically free from pitting. It is impossible to state whether the oxide was formed shortly after the plant was started and that corrosion had ceased, or whether it was the result of continuous action. Even if the second assumption were correct, it would require many years for corrosion to proceed so far that the tower would be in danger of failing.

Several feet of sediment, largely lime, was found the treating tower. This was sluiced out with a hose. A tank with a cone-shaped bottom would permit the complete removal of this sediment at intervals while the plant is in operation.

Little corrosion had taken place in the washing tower. In spots the interior was somewhat roughened but for the most part it was smooth and bright. Some consideration has been given to the selection of a material suitable for lining the towers, should a more extended experience prove this necessary.

RESISTANT MATERIALS

Tests are now in progress to determine whether acid-proof paint will withstand the corroding action of the solution. Test-pieces, thoroughly cleaned, were painted and immersed in the aërating tank. These tests have not proceeded far enough to warrant a decision as to the suitability of such paint for the purpose. A lead lining such as is used in acid-treating plants would undoubtedly give satisfactory service, but a zinc lining would be still more durable. This metal is practically inert when exposed to hypochlorite solution⁸ and possesses the added advantage of being electropositive to iron.⁹ Should it be decided to employ this metal, serious consideration should be given to the method of application.

The use of galvanized iron plates in the construction of those tanks which are exposed to the solution is not altogether satisfactory since the film of zinc would be broken in many places during the construction of the tanks, thus exposing the iron. Also the film of zinc deposited in the galvanizing process is not as thick as

seems desirable for this purpose. A method which seems applicable was described by Henry Hess in *Chemical & Metallurgical Engineering* several years ago.⁵ Finely powdered zinc, to which finely powdered lead and tin have been added, is mixed to a paste with a suitable flux and applied with a brush. By heating with a blast torch the metals are melted and form a tough, adherent coating. By adding the proper amounts of tin and lead it is claimed that greater toughness is obtained without losing the electro-positive property of the coating.

Experience to date indicates that the oxide formed by contact with the hypochlorite solution furnishes quite efficient protection to the metal beneath. If the treating and washing towers were constructed from extra heavy steel there is little doubt that a long life could be obtained at moderate cost. For both solution and water lines the use of pipe galvanized inside is recommended.

OPERATING PRACTICE

The consumption of bleaching powder is about 2.75 lb. per 1,000 gal., or 0.1155 lb. per barrel. This is somewhat higher than the consumption indicated by the preliminary tests. Probably the greatest contributing factor is the carrying over of solution into the washing tower. Other sources of loss are leakage of solution through the pump, exposure of solution in the aërating tower to diffused light and occasional overflows of the aërating tower.

As both the naphtha and the compression product are sour, it is necessary to sweeten the entire volume of blend. At present the plant is producing about 75,000 to 85,000 gal. of blend daily, which the treating plant is handling very satisfactorily. Construction is now in progress for doubling the output of the gasoline plant, and it is the opinion of the authors that the present treating plant, with possibly some minor changes, will handle the increased production.

TESTS ON REFINERY PRODUCTS

A series of experiments were made during the months of July and August, 1921, at the Midwest Refinery at Casper to test the adaptability of the process to refinery products. These tests proved that some heavy naphthas could be treated economically, while others could not be treated at all. Lighter naphthas could be treated, but with a somewhat higher consumption of bleaching powder than that experienced in handling the blend at Salt Creek. Gasoline which had passed the steam stills could be treated easily and economically. A large amount of such gasoline was in storage which the management was particularly anxious to prepare for market. It was decided to connect up four towers of a plant formerly used for treating pressure still distillate to form a plant for treating this product.

This improvised plant differed in some respects from the plant at Salt Creek. Since the gasoline was not "wild," the weathering tower was omitted. The towers were, in order, for treating, settling, washing and settling. All the towers were about 20 ft. in height; the diameters were, in order, 5 ft., 5 ft., 6 ft. and 7 ft. Three pumps were used, one for gasoline.

^{2a} "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," by J. W. Mellor, vol. 2, p. 253.

*"The Protection of Iron by Electroplating," by Oliver P. Watts and Paul L. DeVerter, *Trans. Am. Electrochem. Soc.*, vol. 30, p. 145.

²Chem. & Met. Eng., vol. 16, p. 13, Jan. 1, 1917.

one for solution and one for wash water. The bleaching powder was mixed in a tank from which the solution would gravitate into the aerating tank. The pump drew the solution from this tank and forced it through the mixer into the treating tower, from which it was returned by pressure to the aerating tank or to the mixing tank, as desired. Due to the limited capacity for both aerating and treating, only about 4,200 gal. of solution could be handled advantageously. During the first continuous run, lasting over 20 hours, gasoline was treated at the rate of about 6,500 bbl. per 24 hours. This plant was operated until the entire volume of sour gasoline in storage was treated.

Very little solution was carried over into the first settling tower, but a considerable volume of emulsion was drawn from this tower. There was a decided tendency for the gasoline to be carried into the aerating tank with the returning solution. The treating tower was so small and the circulation of the solution so rapid that there was no opportunity for the mixture to "break," thus allowing the gasoline to rise and the solution to settle.

CHEMICAL TESTS

The details of preparing doctor solution and the procedure in making the test are described in detail in several publications.*

A standard solution of either sodium arsenite or sodium thiosulphate may be used in the determination of the available chlorine present in solutions and in samples of bleaching powder. A solution approximately tenth normal is convenient.[†]

In calculating the pounds of bleaching powder in solution the following formula may be used:

$$\frac{0.003546 \times (X) \times \frac{3785}{25} \times (Y) \times \frac{100}{Z}}{453.6}$$

= pounds of bleaching powder in solution.

In this formula,

X = c.c. of N/10 sodium arsenite or sodium thiosulphate to titrate 25 c.c. of solution.

Y = gallons of solution in circulation.

Z = per cent of available chlorine in the bleaching powder.

For example, should X = 15, Y = 3,000 and Z = 35,

$$\frac{0.003546 \times 15 \times 151.5 \times 3000 \times 2.855}{453.6}$$

= 152.6 pounds of bleaching powder in solution.

TREATMENT OF EMULSION

If any considerable volume of emulsion forms during treatment, provision for the recovery of the gasoline which it contains would probably be a paying investment. This emulsion should be collected in a lead-lined tank, permitted to settle, and the clear solution returned to the system. Some acid, either muriatic or dilute sulphuric, should be added and the contents of the tank thoroughly stirred. After being permitted to settle, the gasoline may be recovered and the sludge run to waste.

*Tech. Paper 214, U. S. Bureau of Mines, pp. 24-25; "Gasoline and Other Motor Fuels," Ellis and Meigs, pp. 59-60; "The Examination of Petroleum," Hamor and Padgett, pp. 59-60.

†Descriptions of methods of preparing standard solutions of sodium thiosulphate and sodium arsenite and for the determination of available chlorine in bleaching powder are contained in practically all books on quantitative analysis. Good descriptions may be found in "Analytical Chemistry," vol. 11, by Treadwell-Hall, "Quantitative Chemical Analysis," by Olsen, and "Quantitative Analysis," by Mahin.

PRECAUTIONS FOR ECONOMICAL USE OF BLEACH

When dissolving bleaching powder all lumps must be broken up. This may be done in a box fitted with a screened bottom, suspended in water. To avoid dusting loss, the transfer of the powder from drum to mixing box should take place where there is no wind.

The powder should not be exposed to the air unnecessarily, especially where it can absorb moisture continuously.

The drums should be stored in a cool, dry, place.

The solution should be protected from diffused light as much as possible and never exposed to direct sunlight.

The solution should be maintained at the lowest strength compatible with safety of operation. This minimizes losses from both mechanical and chemical sources.

Provision should be made for aerating the solution, either by the splash method or by bubbling air through the body of the solution.

Careful attention should be given to the packing of valves and pumps. A seemingly small loss occurring frequently as in case of an improperly packed pump will soon amount to a considerable volume.

As little weathering as possible should be allowed to take place in the treating tower. Ebullition in this tower carries solution over into the washing tower. Loss from this source will greatly increase the consumption of bleaching powder.

CONCLUSIONS

The process described is not suitable for sweetening heavy naphthas, but is suitable for sweetening gasoline from the steam still or direct from the fire still, and is especially suitable for treating natural gas gasoline.

With a well-designed and well-constructed plant a large volume of gasoline can be sweetened with low cost for supplies, attendance and upkeep of plant.

ACKNOWLEDGMENTS

The design and construction of the plant was under the supervision of W. R. Finney, superintendent of gas department; A. C. Andrews, superintendent of the Salt Creek gas plant, was in direct charge of construction. Both offered many suggestions which were incorporated in the plant, and have since helped in many ways in improving the operation of the plant.

E. Buddrus, laboratory foreman at the time the preliminary tests were being made, exercised painstaking care in making these tests.

A. J. L. Hutchinson, who joined the staff after the plant was in operation, has aided in clearing up some of the chemical problems which were not fully investigated when the details of the process were being worked out, and has also offered valuable suggestions in the preparation of this article.

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Sensitiveness of Gasoline Vapors to Ignition

Tests have been conducted at Pittsburgh, Pa., by the United States Bureau of Mines to obtain data as to the comparative sensitiveness of gasoline vapors and methane with respect to their ignition from electric flashes.

*The properties of bleaching powder are covered in great detail in "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," by J. W. Mellor, vol. 2, p. 258 *et seq.* Information of value is also contained in "Outlines of Industrial Chemistry," by Thorp, 3rd ed., pp. 132-135.

A New Induction Furnace*

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IT IS the object of this paper to describe a new induction furnace for melting non-ferrous metals, possessing some features which differ radically from those found in any previous furnace and affording great flexibility of design and a broad scope of application.

In this furnace, as in other induction furnaces, the heat is produced by an electric current induced by transformer action in a looped portion of the molten charge, which we will call the secondary. This secondary is distinct from the melting chamber pot, in which the cold charge is received, melted and held for refining and pouring. The success of the furnace depends upon a continuous, automatic circulation of the molten metal between the secondary and the melting pot, to prevent overheating in the former and to deliver the heat to the cold metal in the latter. It is in the form of the secondary, and in the character of the circulation and the method of producing it, that the new fundamental features of this furnace are found.

The secondary loop in this furnace closes upon itself without passing through the melting chamber, as illustrated by sectional views in Fig. 1. It is in the form of a hollow cylinder, of considerable length, which communicates with the melting chamber through two distinct ports or passages, from opposite ends of the cylinder. The current flows around the cylinder in a circumferential direction without entering the chamber or communicating passages, while the circulating charge flows through it in an axial direction, transverse to the current. The movement of the molten metal is unidirectional, from the secondary cylinder to the melting chamber by one passage and from that chamber back to the secondary by the other.

MECHANISM OF CIRCULATION IN SECONDARY

The circulation in this furnace is effected by the force of electromagnetic repulsion, set up through the medium of the magnetic leakage field, which exists between primary and secondary in any transformer. This force is proportional to the square of the current flowing, and is familiar to all transformer engineers as having caused much trouble in the wrecking of transformers when the windings were not held with sufficient rigidity to withstand the enormous forces of this nature which are set up when short circuits occur.

The induction furnace is, in fact, a special case of a short-circuited transformer, in which the internal impedance is comparable with the total full load impedance of the secondary circuit of the ordinary transformer. The repulsive force in this furnace, therefore, is not excessive, as in ordinary transformers when short-circuited, but only such as exists in ordinary transformers when normally loaded.

Some explanation may assist in understanding how this repulsive force becomes effective in producing circulation of the molten material through the secondary, while the secondary itself is fixed in position.

In the case of an ordinary transformer, with solid secondary, relative motion between primary and secondary occurs only when the strength of the structure supporting the windings is not sufficient to withstand

the force corresponding to the current flowing, and when such motion does occur, the current and its conducting medium, the solid metal of the coil, necessarily move together. In this furnace the case is quite different. The repulsive force will always be small, relative to the physical strength of the structure as a whole, and while the secondary current and the position of the secondary do not shift, yet the secondary conducting medium can and does flow. This difference is understood after considering the nature of the magnetic leakage field, which is the same in both cases, and the natural effect of the modified conditions upon its action.

The physical characteristics by which any magnetic field makes itself apparent are those of mechanical attraction and repulsion, and of inducing voltages in conducting media when relative motion not parallel to the field occurs between it and the conducting medium. A force of attraction exists between unlike magnetic poles, while a force of repulsion exists between like poles. The former force is due to a tractive effort or tensile stress exerted by the field in directions parallel to itself, while the latter is due to a pushing effort or compressive stress in a direction at right angles to the field. These stresses are true mechanical stresses, measurable in grams per sq.cm. or pounds per sq.in., which exist simultaneously in any magnetic field and which produce the results which such stresses would be expected to produce.

The stress involved here is that of pressure at right angles to the field, this field being the leakage field between primary and secondary. In the case of the solid secondary of the ordinary transformer, if it is free to move, bodily motion will be produced. If it is properly supported, although mechanical pressure is produced, no movement occurs. In the case of the fluid secondary of the furnace, the mechanical pressure appears as a fluid pressure and even though the secondary as a whole is not free to move, this fluid pressure, if not uniform and if permitted to do so, will cause the metal to flow from points of higher pressure to points

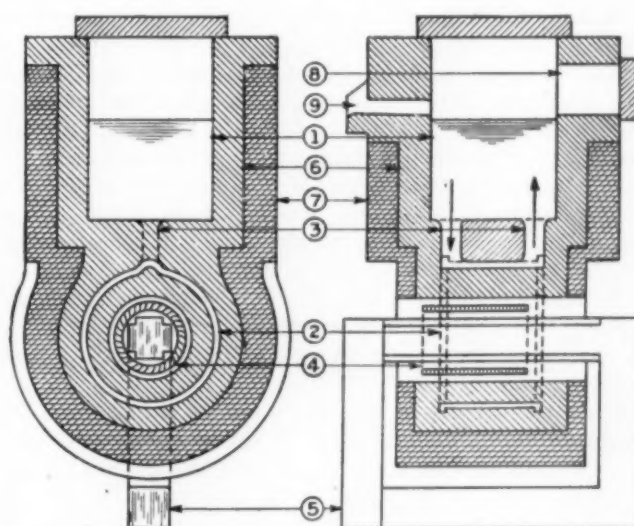


FIG. 1—TWO VERTICAL SECTIONS OF THE FURNACE AT RIGHT ANGLES TO EACH OTHER

1. Molten metal bath in melting chamber; 2. Molten metal secondary cylinder in which heat is generated by induced currents; 3. Ducts for unidirectional circulation of the metal; 4. Primary winding; 5. Laminated iron core; 6. Refractory lining; 7. Thermal insulation; 8. Charging door; 9. Pouring spout.

Note the thickened sections at the ends of the secondary cylinder, one serving as a channel for distributing the metal around the perimeter of the cylinder and the other for collecting it. The flow within the main body of the cylinder is in an axial direction.

Note the axial displacement of the primary winding with respect to the secondary. The velocity of the circulation of the metal may be varied by shifting the position of this winding.

*Paper presented at the forty-second general meeting of the American Electrochemical Society in Montreal, Sept. 21, 22 and 23, 1922.

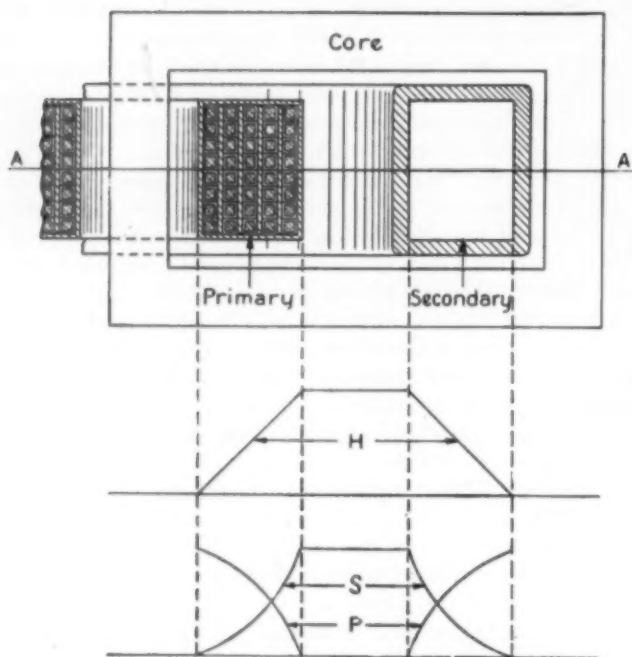


FIG. 2—TRANSVERSE SECTION THROUGH PRIMARY AND SECONDARY OF A HYPOTHETICAL FURNACE, WITH CURVES

H shows the variation of the density of the magnetic leakage field between primary and secondary along lines parallel to A-A. *S* shows the variation of the stress in the field which is proportional at every point to the square of the density. *P* shows the variation of the fluid pressure in the molten metal. The difference between the fluid pressures at two points is equal to the difference between the corresponding stresses of the field. The maximum fluid pressure occurs in the part of the secondary most distant from the primary where the minimum stress is found.

of lower pressure. It remains now to show that the pressure is greater at certain points in the secondary than at certain others, and to show how this pressure difference is utilized to produce the desired circulation.

The leakage flux between primary and secondary is not all confined between their adjacent boundaries. This matter has been carefully investigated for transformers, and for an arrangement with transverse cross-section, such as is illustrated in Fig. 2, for instance, the distribution of the leakage field is shown by the curve *H*, the ordinates representing the magnetic densities at points along lines parallel to A-A. In both primary and secondary, the density falls away gradually, from its maximum value at adjacent boundaries, and disappears at the further boundaries. As the stress in the field at any point is proportional to the square of the density, the variation of the stress along the line A-A is in accordance with the curve *S*. This, however, does not signify that the mechanical or fluid pressure imparted to the secondary (or primary) is represented at each point by the ordinate of curve *S*.

Were the density of the field uniform throughout, the magnetic stress at any point would be counterbalanced by equal stresses at all other points, and no mechanical pressure would be imparted to the material medium. It is only the difference between the magnetic stresses at given points in the secondary that appears between those points as mechanical pressure.

If the differentials of pressure be added along the line A-A, from the side of the secondary nearest to the primary to the side farthest from it, the integrated or effective pressure will be represented by curve *P*, such that the ordinate of *P* at any point added to the ordinate of *S* equals the maximum value of *S*. The ordinate of curve *P* at any point represents a pressure

difference between that point and a point at the side of the secondary nearest to the primary.

In the case of the fluid secondary found in the furnace, this pressure difference constitutes a difference of fluid pressure. It cannot equalize itself within the secondary, since it is opposed by the stresses of the field which sets it up. If, however, a passage or passages be provided external to the secondary, from the point of maximum pressure (farthest from the primary) to the point of minimum pressure (closest to the primary), as illustrated in Fig. 3, the pressure difference will cause the fluid to flow, as indicated by the arrows.

The pressure causing this flow will be maintained by the field, with a corresponding internal flow from the point of minimum pressure to the point of maximum pressure. The strength of flow will be such that the sum of the internal and external pressure drops due to friction will be equal to the total pressure imparted or generated by the field.

Figs. 2 and 3 have been used here for the purpose of illustrating, in the simplest manner, the principle involved. The arrangement of primary and secondary in the furnace, as actually developed and represented in Fig. 1, differs from that in Figs. 2 and 3 for practical reasons, but the principle is the same. Maximum and minimum fluid pressures are found at the ends of the secondary cylinder which are respectively farthest from and nearest to the primary winding as a whole, or to use a form of expression common with transformer designing engineers but somewhat lacking in definition, at the ends which are farthest from and nearest to the magnetic center of the primary winding. This pressure distribution results from the diagonal arrangement of the leakage field, due to the axial displacement between the primary and secondary. It is the radial component of this field which generates the pressure difference between the two ends of the cylinder.

That the axial forces set up in such an arrangement are substantial realities has been demonstrated by experience in transformers with windings of the concentric cylindrical type. Comparatively small axial displacements of these windings have, upon numerous occasions, resulted in crushing the mechanical supports of the coils and deforming the coils themselves, the primary being driven in one direction against the yoke

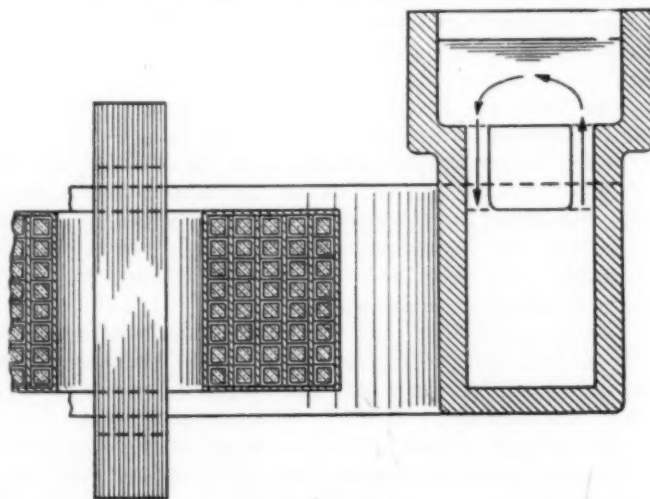


FIG. 3

Section of hypothetical furnace shown in Fig. 2, perpendicular to the section in that figure. The arrows show the way molten metal would flow through the external channel and reservoir, from the point of higher fluid pressure in the secondary to the point of lower fluid pressure.

of the core, and the secondary in the other. The differences in fluid pressure between the two ends of the secondary cylinder in the furnace are demonstrated by the flow of the molten metal in the furnace. Any reasonable velocity of the circulation can be easily obtained, by merely adjusting the axial position of the primary winding with respect to the secondary, for which provision is made in the mechanical design of the furnace.

As intimated at the beginning of this paper, the chief significance of the new physical features which have been described above lies in their effects upon flexibility of design and scope of application. The free unidirectional circulation, set up by a force which can be controlled within desirable limits, not only restricts the temperature variation of the metal to a small value but also avoids the danger of magnetic choking.

This makes it practicable to force the furnace to any extent which is feasible for the primary winding and core, and particularly adapts it for the melting of high conductivity metals, such as copper, as well as of metals of lower conductivity. The form of the secondary is favorable to flexibility of design as regards size and capacity. The only limiting feature in this direction consists in the refractory lining, due to considerations of mechanical strength and general reliability. Such limits are probably capable of indefinite expansion. Increased size and capacity will have no necessary effect upon the power factor, which is inherently high with the long thin section of the secondary.

Notes on the Swedish Paper Industry

IN *Commerce Reports* for Aug. 21, 1922, there is an interesting summary of the history and present status of the paper industry in Sweden. The establishment of the Swedish paper industry dates back to the sixteenth century, but it was not until recent years that it came to occupy a place of prominence in Swedish economic life, and the firm establishment of Swedish paper as an article of export is of still more recent date.

The Swedish mills are thoroughly modern, employing electrical power to a great extent, and produce a great variety of paper, such as newsprint, wrapping, parchments, smooth foolscap, writing, thin printing, colored tissue, crêpe and waxed tissue, affiche, catalog, envelope, sealings and toilet. Production of cardboards includes leather board, duplex and triplex boards.

There are at present 74 mills in Sweden, with a total yearly capacity of 400,000 tons of paper and 75,000 tons of cardboard. Of this amount, approximately 45 per cent is exported. While most of the mills are comparatively small, some are quite large, the three most important (Karan, papyrus, and Holmen) having yearly capacities of from 30,000 to 50,000 tons. The chief grades produced for export are newsprint and wrapping paper, both of which enjoy an excellent reputation in foreign markets.

Great Britain has always been the chief market for Swedish paper products and remained so during and after the war, with France, Brazil, Australia, Denmark, Hungary, Argentina and Rumania following in the order named. Exports to the United States, especially newsprint, have increased steadily. The total exports of newsprint from Sweden to the United States in 1912 amounted to only about 300 tons, while the estimated figure for 1921 reached 30,000 tons. The grow-

ing importance of the American market to Swedish paper manufacturers can best be appreciated when it is noted that, of the 12,345 tons of newsprint exported during May, 1922, 7,000 tons were shipped to the United States.

EXPORTS OF SWEDISH PAPERS

The following table shows exports of Swedish newsprint and other paper and cardboard during 1913, 1920, 1921 and the first 5 months of 1922:

SWEDISH EXPORTS OF PAPER AND CARDBOARD			
Years	Newsprint, Tons	Other Paper, Tons	Total, Tons
1913.....	61,650	151,020	212,670
1920.....	116,430	169,760	286,190
1921.....	111,530	71,570	183,100
1922:			
January.....	10,360	7,980	18,340
February.....	3,560	4,950	8,510
March.....	6,600	12,250	18,850
April.....	5,070	7,730	12,800
May*.....			26,000

* Estimated.

The preceding table illustrates the extreme depression which the Swedish paper industry suffered during 1921 and from which it is now very slowly recovering. The crisis is by far the most serious experienced since the industry's establishment. The competition from the countries with low-value exchanges, such as Finland and Germany, has been keenly felt, because both of these countries possess large and highly developed paper industries.

Furthermore, the cost of production for the Swedish mills was for a long time kept above a point permitting successful competition, because of the extraordinarily high wages which were being upheld by strongly organized labor.

RECOVERY OF INDUSTRY EXPECTED IN 1922

Developments which have so far taken place during 1922 promise a return to normal conditions. Production costs have been cut considerably through wage reductions averaging from 25 to 40 per cent. Furthermore, the competition from Finland, while still felt, is not so severe and that from Germany is rapidly disappearing, owing to the steady rise of German prices toward world market levels and the difficulties experienced by German manufacturers in effecting prompt deliveries. On June 15 all mills except those producing boards were running at full capacity and were reported as having advance orders assuring steady occupation for some time to come.

ORGANIZATION OF PAPER MANUFACTURERS

Practically all Swedish paper and cardboard manufacturers are organized in what is known as the Sveriges Papperbruksforening (Swedish Paper Manufacturers' Association), which is a general trade organization serving the industry much in the same way as other trade organizations do their industries, without having any price regulations or control features.

During the last week of June an export association has been formed by Norwegian, Swedish and Finnish paper manufacturers of newsprint. The scope of this association is not yet known, but it is understood that it is organized for the sole purpose of promoting sales of Scandinavian and Finnish newsprint in the United States. It is reported that German exporters are to be affiliated with the new export organization.

Non-Metallic Inclusions and Ferrite Segregation in Steel*

BY E. G. MAHIN AND H. W. BOTTS
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IN THREE earlier papers¹ experimental evidence has been submitted indicating that the effect of non-metallic inclusions upon carbon segregation in steel is due to the fact that in a narrow surrounding zone the steel is saturated with the material of the inclusion itself and with equilibrium products of reactions between the inclusion material and other constituents of the steel. In this zone the ideal equilibrium between austenite and ferrite at the upper transformation point is upset by the dissolved impurities so derived, this resulting in premature ferrite separation. As soon as such separation begins, the supersaturation of austenite with ferrite, as it ordinarily exists at A_r , is relieved by continued separation about these localities.

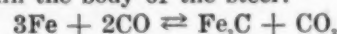
Reference was made to Stead's theory² that iron phosphide is alone responsible for ferrite segregation, the presence of inclusions in the same localities being regarded by him as a coincidence, rather than a cause. But we called attention to the fact that iron phosphide is probably only one of a considerable number of such impurities, any of which may exert a similar influence. There is reason for believing that many of these may come from non-metallic inclusions, remaining permanently segregated about the latter.

Segregation of ferrite and cementite about non-metallic inclusions is a phenomenon that has long been familiar to metallographists; the only difference of opinion is with regard to the cause. Most of the theories that have been proposed also are familiar. Ziegler's theory³ that inclusions act as crystallization nuclei for ferrite has never been generally accepted. Howe supposed⁴ that inclusions are rejected from crystallizing austenite to the grain boundaries, where ferrite also is expelled during passage through the temperature range A_r to A_{r_1} . It was shown by one of us¹ that neither Stead's nor Howe's theory accounted satisfactorily for all of the observed cases. The form and relative positions of inclusions remain practically unaltered by protracted and repeated heat-treatment that totally changes pre-existing grain sizes and forms. Such treatment results also in complete elimination of ghosts of phosphorus and ferrite in rolled steel, but it does not eliminate, in any degree, ferrite segregation about inclusions.

OXIDIZED INCLUSIONS

Giolitti has vigorously supported⁵ his conclusion that it is only "oxidized" inclusions that show any effect upon

ferrite segregation and that if the steel is cooled during or immediately after carburization, inclusions do not surround themselves with ferrite. He has argued that the well-known fact that all steels contain certain quantities of dissolved gases is responsible for the reversible reaction within the body of the steel:



the equilibrium of which is shifted in either direction, according to whether the piece is bathed in oxidizing or in reducing gases. The "oxidized" inclusion would be supposed to suppress this reaction to some extent, thus producing a thin sheath of ferrite about the inclusion, which would naturally act as a nucleus for further ferrite crystallization. On the other hand, if the piece of steel were heated in a reducing atmosphere, the resulting carburization and excess of carbon monoxide would be expected to prevent the "free iron" formation. In the last paper just cited Giolitti stated that if a piece of steel⁶ containing ferrite segregated about inclusions be heated to a temperature of 1,000 deg. C. for 24 hours in carbon monoxide, ferrite segregation is eliminated, only to reappear if the piece is reheated in carbon dioxide.

In none of the available papers by Giolitti nor in his book "Heat-Treatment of Soft and Medium Steel" is there given any clear definition as to what are to be considered as "oxidized" inclusions. It is difficult to see how such inclusions as sulphide of manganese (the most common and abundant of all inclusions in even the "cleanest" steel) or sulphide of iron could be oxidizing in any sense of the word, and we are quite certain that the ubiquitous manganese sulphide is one of the most active of all inclusions in connection with ferrite segregation. If the "oxidized" inclusions are to be understood as being, for the most part, of the general nature of silicates (the ordinary slag inclusions of iron and steel), it is worth our while to examine the thermochem-

*[Dr. Giolitti's experiments were made on medium carbon-chromium and nickel steels made in an acid open-hearth furnace.—EDITOR.]

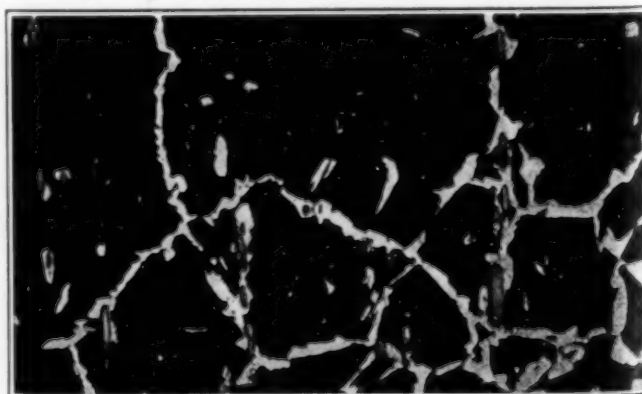


FIG. 1—INCLUSION IN STEEL CARBURIZED BY CONTACT WITH GRAY IRON CRUCIBLE. $\times 100$

*A paper presented before the Division of Industrial and Engineering Chemistry of the American Chemical Society at the Pittsburgh meeting, September, 1922.

¹*J. Ind. Eng. Chem.*, vol. 11, p. 739 (1919); vol. 12, pp. 1090, 1095 (1920). Abstracted in this issue, page 990.

²*J. Iron & Steel Inst.*, vol. 58, p. 60 (1900); vol. 91, p. 140 (1915); vol. 97, pp. 287, 389 (1918).

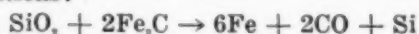
³*Revue de Metall.*, vol. 8, p. 655 (1911).

⁴*Proc., Am. Soc. Test. Mat.*, vol. 11, p. 271 (1911); "The Metallography of Steel and Cast Iron," p. 280.

⁵*Ann. chim. applicata*, vol. 2, p. 218 (1914); *Intern. Z. Metallog.*, vol. 7, p. 35 (1914); *Chem. & Met.*, vol. 20, p. 271 (1919).

istry and the general physical conceptions involved in Giolitti's assumptions.

If this is the true mechanism of ferrite segregation about inclusions, any influence of the material of the inclusion upon the shifting of equilibrium conditions of the reaction expressed above would mean, as a *net* result, that carbon would be oxidized at the expense of silicon dioxide of silicates. The relatively large positive heat of oxidation of silicon ($\text{Si} + \text{O}_2 = \text{SiO}_2 + 180,000 \text{ cal.}$) and the heat of formation of iron carbide ($3\text{Fe} + \text{C} = \text{Fe}_3\text{C} + 8,460 \text{ cal.}$) makes it appear improbable that more than a very minute amount of carbon could be oxidized at the expense of silicon dioxide, even at high temperatures. Without regard to intermediate steps, the following changes are to be considered as representing final conditions:



$$[2(29,160 - 180,000 - 2(8,460)) = -138,600] \text{ cal.}$$

Naturally such a reduction of a silicate would involve the simultaneous formation of some sort of silicide. We have no thermochemical data regarding this reaction, but it does not seem likely that its consideration would materially change the conclusion that equilibrium would be established by a very slight reduction of the silicate, even at 1,000 deg. C. Of course there is to be considered also the possibility that the action of the inclusion may be of a catalytic nature.

If the inclusions that are considered to be responsible for ferrite segregation are understood to be oxides (of nickel or chromium?) only, we still have to account for the fact that plain carbon steels show the same effects.

The second objection to this conception lies in the difficulty in understanding how the preponderance of carbon dioxide or of carbon monoxide in the atmosphere surrounding the piece as a whole could have any such effect as Giolitti outlines at the surface of contact between metal and inclusion. A change in outside environment would, of course, alter the relative concentrations of the respective gases dissolved in the metal, but these gases would have to diffuse through the body of the steel in order to reach the inclusion and there seems no good reason why their action upon carbides should be delayed until contact with inclusions is established, unless the latter act as adsorption or catalytic centers—a hypothesis in support of which there appears to be no experimental evidence. In other words, if an inclusion acts at all in the sense of surrounding itself with an envelope of carbonless iron, this action should be noticed, no matter what might be the nature of the surrounding gases and, furthermore, the effect should be more striking in the case where the average carbon content is being *increased*, rather than decreased—that is, in the case where the piece is heated in a reducing atmosphere. This is because in such a case there would be the greatest possible difference between carbon content near the surface of the inclusion and that at a distance from it. This is the opposite of the conclusion as stated by Giolitti.

FERRITE SEPARATION A PHYSICAL PROCESS

In the attempt to understand the mechanism of the separation of ferrite in a cooling steel it is well to recall that this is a physical separation from a true solution and not simply a chemical oxidation of a compound. In order to act as a nucleus for continued crystallization of ferrite, any oxidation of carbon would have to *precede*

the normal separation at the point that would otherwise be Ar_3 . Whether austenite be regarded as a solution of elementary carbon or of iron carbide in iron (and this point appears to be more or less of a quibble, in the light of X-ray evidence as to the probable crystal lattice of the solution), the only sense in which "free" iron has any meaning is with reference to iron actually thrown out of solution as ferrite. Considering the system above Ar_3 , if there is a certain amount of oxidation of carbon at the surface of the inclusion, the excess iron so produced is not essentially different from iron already present as a solvent for carbon and the only obviously possible effect would be a slight local increase in the per cent of iron in the solution. This, it is true, would promote a slightly greater ferrite supersaturation of the cooling solid solution, with consequent breaking down of austenite at these points slightly earlier than at others. The inclusions, then, if active as oxidizing agents (catalytic or direct as Giolitti supposes), should be regarded as surrounding themselves, when above the transformation range, with a zone of austenite slightly poorer in carbon than the average of the steel, rather than with a film of "free" iron. This action should be more or less independent of the nature of surrounding atmosphere. Considering the extreme narrowness of the zone of influence of the inclusion and the very appreciable speed of diffusion of carbon in austenite, one can scarcely suppose that this sort of action can be very important unless oxidation, with consequent gas production, is a continuous process. This is extremely unlikely. It may be remarked also that oxidizing inclusions should exert the opposite effect in hypereutectoid steel, being then found in pearlite grains—a supposition that is contrary to observed facts.

FERRITE MAY SEGREGATE AFTER CARBURIZATION

The foregoing paragraphs contain a brief discussion of some of the theoretical objections to the hypothesis that ferrite segregation about non-metallic inclusions is due only to the oxidizing properties of the latter. We may now mention an even more important objection in the fact that our own experimental results lead in the opposite direction. In Giolitti's paper on flaky and woody structures¹ the statement is made that if a piece of hypoeutectoid steel showing co-segregation of ferrite and inclusions is heated for 24 hours at 1,000 deg. C. in carbon monoxide, it no longer shows ferrite segregation, while if it be reheated in carbon dioxide the ferrite grains again surround the inclusions. We have heated a piece of 55-point carbon steel at 1,100 deg. C. for 72 hours in a cast-iron crucible and covered with fusible glass². The environment here was certainly not oxidizing in nature. On the contrary, the portions of the piece that were in contact with the gray iron crucible were highly carburized, the effect being similar to that of ordinary case-carburizing. Fig. 1 shows a section, longitudinal to the direction of rolling, taken where the carbon had approached eutectic proportions and where, presumably, it was still increasing when the piece was furnace-cooled. Ferrite segregation is as pronounced as before. Transverse sections at higher magnification, taken at points in the interior of the piece, where the carbon had not increased to any notable degree but where the conditions were necessarily slightly reducing, show inclusions surrounded by much thicker shells of

¹Chem. & Met., vol. 20, p. 271 (1919).

²J. Ind. Eng. Chem., vol. 11, p. 739 (1919).

ferrite. Fig. 2 illustrates a similar state of affairs in another piece. A $\frac{1}{4}$ -in. rod (0.07 per cent carbon) was packed in a carburizing mixture and heated at 1,000 deg. C. for 6 hours. A deep case was thus produced and Fig. 2 represents a portion near the inner border of the eutectoid zone.

The results of these experiments would not seem to indicate any necessary connection between the existence of an oxidizing atmosphere and co-segregation of ferrite and inclusions.

INCLUSIONS AS CENTERS OF CONTAMINATION

Manganese sulphide is usually regarded as being formed by the reaction of manganese which has been added to liquid steel containing ferrous sulphide, the latter probably being largely in solution at this temperature. The formation of MnS inclusions would then be the result of precipitation from solution, analogous to precipitation by ordinary reactions in ordinary solutions. The reaction



supersaturates the solution with MnS before precipitation begins. Under conditions otherwise static, equilibrium would finally result with the mother liquor saturated with MnS and containing a certain definite concentration of FeS. McCance⁹ does not regard this reaction as being a "balanced" one, but his view can be correct only in a relative sense, for, even though the concentrations of Mn, MnS and FeS in the liquid immediately surrounding the precipitated globule may necessarily be very small, we are not justified in regarding either the formation or the precipitation of MnS as being absolutely complete. As the steel further cools through the region between the liquidus and solidus, these particles are usually caught between large austenite grains, and here they remain in the finally cooled solid steel.

We may assume also that metal in contact with each particle of true slag or of any other suspended material is saturated with the material of the inclusion and with products of any possible reaction between this material and iron. This statement does not imply that inclusion material is soluble to any large degree, but our ideas of physical equilibria make us reluctant to conclude that these particles could have zero solubility.

This conception leads to the conclusion that non-metallic inclusions in iron and steel (and alloys as well) must always be surrounded by zones of segregation in which the metal is contaminated by soluble impurities or by eutectoids of these with the material of the body metal, and that no amount of heating can serve to eliminate this, because the supply is practically inexhaustible. No doubt these zones are extremely narrow in

⁹J. Iron & Steel Inst., vol. 97, p. 239 (1918).

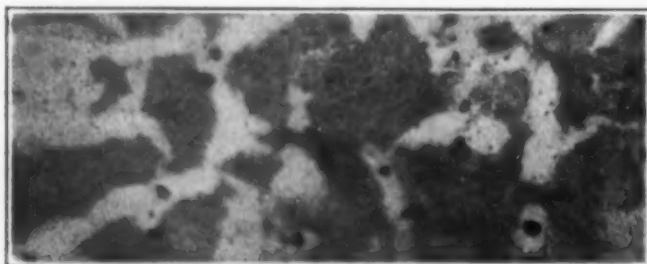


FIG. 2—CORE OF 0.07 C STEEL, CARBURIZED AT 1,000 DEG. C. $\times 250$



Fig. 3—Carbon steel heated after being plugged with aluminum bronze. $\times 100$.

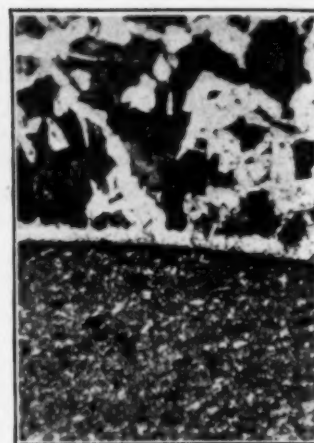


Fig. 4—Carbon steel heated after being plugged with high-speed steel. $\times 100$.

some cases, and the concentration of the contaminating elements or compounds is probably nearly always very low. But only a trace of such material is needed to upset the stressed condition which obtains as the solution cools past the ideal transformation point, and only a trace of ferrite, separated as a result of the influence of this material, is required to "seed" the solid solution and thus to start the breakdown of austenite.

Inclusions are occasionally found touching grains of pearlite or even entirely imbedded in them. We should expect certain exceptions of this kind, in view of the fact that constantly shifting temperature gradients involve corresponding shifts of dissolved impurities, including the contaminations associated with the inclusions as well as the carbon itself. This movement of dissolved matter may occasionally leave a given side of an inclusion unprotected, with the result that on this side there will be no premature ferrite separation.

We should note also that the most obvious cases of inclusions lying in pearlite grains are usually to be found in steels that are of nearly eutectoid composition. In such steels there is a very short temperature range between A_{r1} and A_{r2} , the entire breakdown of austenite occurring in such a short space of time and from a system containing so little excess of ferrite that the latter could not possess any very great migratory power. Inclusions can then show little or no effect upon ferrite separation.

Experimental evidence has already been presented¹⁰ to show that, in many cases, segregated impurities in hypoeutectoid steel cause decided segregation of ferrite and that phosphorus segregation is only one of many similar causes of this phenomenon. Specimens of the steel, into which had been driven small rods of dissimilar materials, were heated. These rods were of non-ferrous alloys and also of steels similar in composition to the body steel, except that each insert contained an abnormal per cent of some one element. After holding such composite specimens at temperatures above the transformation range for varying periods of time and then cooling in the furnace, the insert was often found to be surrounded by a well-defined ferrite ring. (Figs. 3 and 4.)

OXIDATION RINGS

Probably every metallographist has noticed that at times a polished specimen persistently develops minute

¹⁰J. Ind. Eng. Chem., vol. 12, p. 1090 (1920).

dark spots which prove to be colored rings or halos with non-metallic inclusions at their centers. These rings usually form while drying the polished and washed specimen, either before or after etching, although they may appear also if the specimen is permitted to heat slightly during the final polishing or if it is heat-tinted. Colored rings are merely one example of selective oxidation. They indicate potential differences existing between the zones immediately surrounding the central inclusions and the main portions of the metal, and these potential differences are undoubtedly due to slight differences in the chemical composition of the metal at various distances from the inclusion. It seems obvious either that the inclusion is a source of contamination for the metal or that the metal retains a trace of the substance which was not expelled during the process of precipitation at high temperatures or upon cooling.

We have examined a large number of oxidation rings in wrought iron and steel; some are shown in Fig. 5.

Whiteley's antimony solution¹¹ (5 grams of gelatin, 15 c.c. of glycerine, 0.05 gram of tartar emetic and 1 c.c. of dilute sulphuric acid in 20 c.c. of water) and McCance's silver nitrate modification¹² (substituting 0.1 gram of silver nitrate for tartar emetic) were applied to some of these materials to determine whether sulphide inclusions were centers of segregation. The evolution of minute gas bubbles, which were caught in the overlying gelatin, made it necessary to strip off the gelatin films before microscopic examination, and we finally omitted the gelatin entirely, simply dipping the specimen in the solution for a short time, then gently washing and drying.

Silver nitrate is not satisfactory for this purpose. Well-defined dark rings were produced, but the silver sulphide in thin layers is so nearly the color of the oxide rings that it was often impossible to decide whether the rings finally remaining were silver sulphide or iron oxide, the latter developed during drying. Antimony tartrate solution with the gelatin omitted is excellent

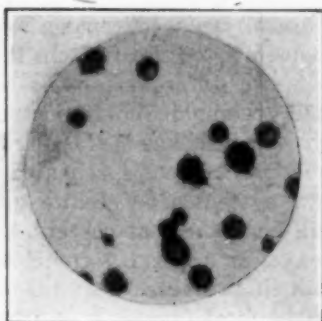


Fig. 5—Oxidation halos on Thermite iron; developed during drying of polished section. $\times 100$.

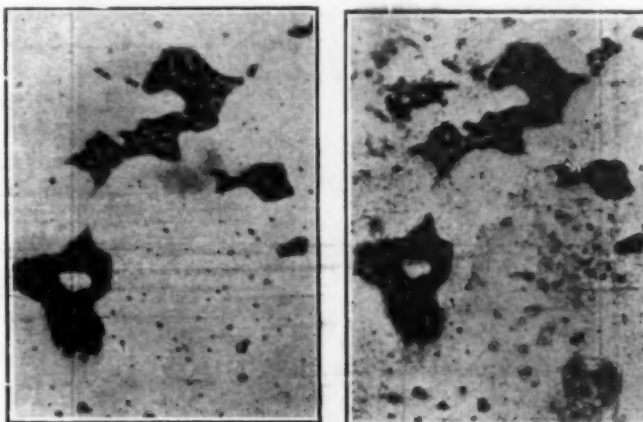
for the purpose. Antimony sulphide is so distinctly yellow that it is easily distinguished (Fig. 6).

The alternating concentric rings, often constituting the halos of sulphide inclusions, are zones of higher concentrations of soluble sulphides. Their periodic recurrence is possibly due to different rates at which the various soluble impurities diffuse. With manganese sulphide inclusions we have to consider MnS, FeS and Mn, since all are presumed to be present at equilibrium.

From the results of these experiments it is possible also to confirm the assumption often made, that many of the small slate-gray inclusions found so abundantly in even high-grade steel and iron are sulphides, the natural assumption being that they are principally manganese sulphide. Even when the inclusion is so small as to make identification from its own appearance very difficult, the yellow antimony sulphide halo leaves no doubt as to its general nature. The application of the modified McCance's solution to the mottled "slag" inclusions of wrought iron and low-grade steel confirms the usual supposition that the lighter parts of these bodies are sulphides (Figs. 7 and 8).

GENESIS OF FERRITE

In his paper dealing with this subject¹³ Giolitti reasoned that ferrite is not expelled to the peripheries of



FIGS. 7 AND 8—TWO VIEWS OF SAME AREA ON WROUGHT IRON. $\times 100$

Fig. 7—Unetched. Fig. 8—Etched with McCance's silver solution.

cooling austenite grains, as maintained by Howe¹⁴ and others, but that it first separates at austenite grain centers as small β -grains, which coalesce as they grow, finally forming a semblance of a network. This assumption seems logical if we are to consider only hypoeutectoid steels, cooling from the liquid state. The mechanism of the crystallization of austenite between the liquidus and the solidus leads necessarily to the formation of grains in which the carbon content is lowest at the nuclei and highest in the outer portions. The natural tendency of grains of the solid solution to reject their excess ferrite to their boundaries at A_r , is then counteracted by the fact that the grain centers reach their transformation temperature first. We should then expect a preliminary formation of either (a) isolated ferrite dots alone, near pearlite grain centers, or (b) ferrite dots and ferrite network, according to the rate of cooling between the solidus and A_r , slower cooling favoring an approach to equalization of carbon content in the grains.

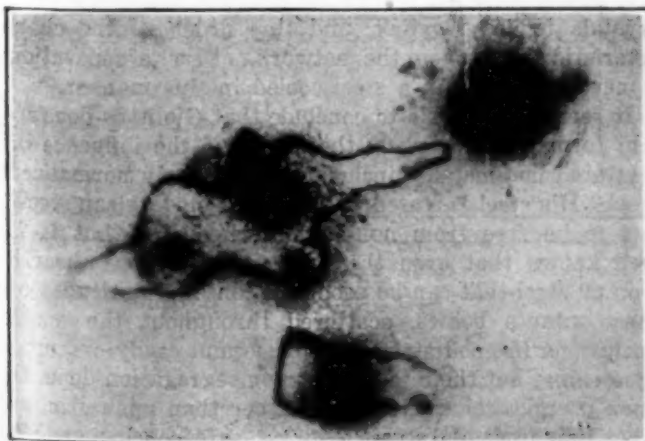


FIG. 6—ANTIMONY SULPHIDE HALOS ON POLISHED SPECIMEN. $\times 250$

¹¹J. West of Scotland Iron & Steel Inst., vol. 24, p. 79 (1917).

¹²Chem. & Met., vol. 22, p. 737 (1920).

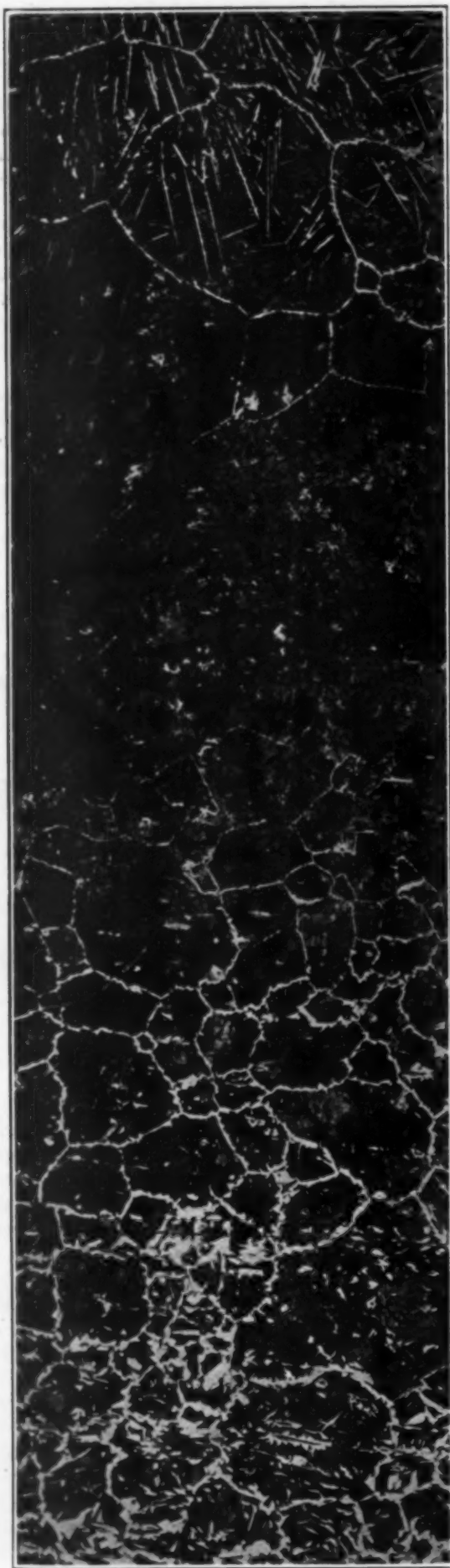


FIG. 9—SECTION ACROSS THE CARBURIZED CASE OF STEEL SHOWN IN FIG. 1. $\times 50$

But if this conception is correct for steel castings, cooled not too slowly from the liquid state, the case must be quite different for the reheated steel, which is far more common and important in practice. No matter by what mechanism the ferrite network was first formed, when the piece is reheated this network will define a new system of austenite grains whose carbon content will be *highest* at centers. Absorption of the network begins at A_c , and is completed at A_{c_1} . It seems obvious that this reverses the situation. The new system is now in the most favorable condition for ferrite network formation upon cooling. Fig. 9 shows a section across the carburized case of the steel described in Fig. 1. It is easy to see here that the very distinct ferrite network thins out to disappearance in practically the same man-

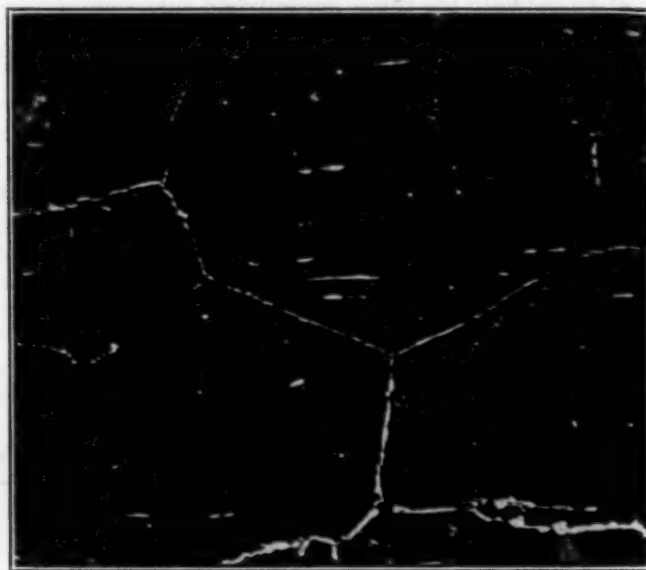


FIG. 10—DISAPPEARING FERRITE NETWORK OF STEEL SHOWN IN FIG. 9. $\times 100$

ner as does the cementite network on the hypereutectoid side. There is no suggestion of random dots at isolated points. Fig. 10 illustrates this still more distinctly.

Fig. 11 shows the typical structure of a coarse-grained hypoeutectoid steel which has been held above the transformation range for some time and then air-cooled. Evidently the process has resulted in the formation of a primary network of ferrite, but, because of the fairly rapid cooling, migration from the interior of the grain was hindered so that excessive supersaturation finally expelled ferrite to cleavage planes between crystals to some extent, and this produced the characteristic fringes on the network. Ferrite separation is never complete in a steel cooled in this manner.

It seems reasonable to conclude that Giolitti's dot ferrite formation is largely the result of the influence of scattered non-metallic inclusions in a nearly normalized steel. His steel is stated to be "a well-made, clean steel" and to be free from non-metallic inclusions, but it is well known that even the best grades of open-hearth iron or steel that can be produced contain multitudes of these minute bodies, scattered throughout the mass. Inclusions in good steel are minute and easily obscured by etching, but their influence upon segregation depends upon chemical characteristics rather than upon size, as already stated. It seems a fairly safe conclusion that the majority of ferrite "islands" found in pearlite grains in any steel are due to segregation of this character.

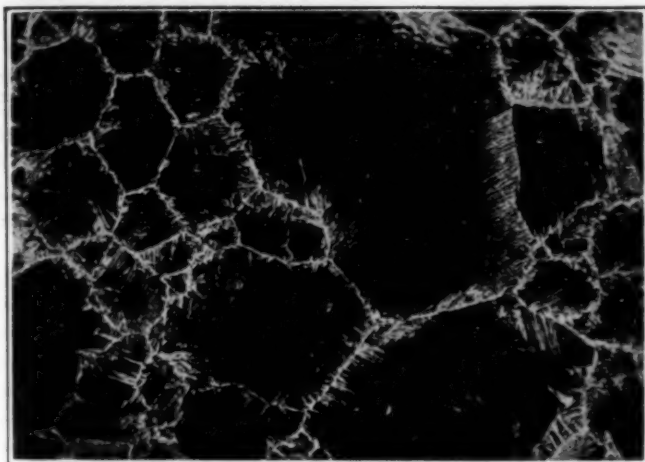


FIG. 11—AIR-COOLED HYPOEUTECTOID STEEL AFTER LONG ANNEALING. $\times 50$

That the inclusion is not always seen in the specimen prepared for the microscope is not to be taken as proof of its absence. Of course the converse is not necessarily true, but since the inclusion is frequently a very small fraction of the ferrite grain surrounding it, the chance that a random section of the grain will contain the inclusion is relatively small.

Giolitti's steel had been heated at 900 deg. C. for 1 hour. Considering the rate of migration of carbon, as evidenced by such a process as case-carburizing or by carbon shift during decomposition of austenite, it is doubtful whether, after such heating, austenite grains a few hundredths of a millimeter in diameter in a 0.62 C steel could retain a carbon content in the grain centers low enough to precipitate β -ferrite granules. This would require that just before reaching A_r , these grain centers should contain less than 0.45 per cent of carbon, but in any ordinary hypoeutectoid steel carbon will migrate one-half the average diameter of the ferrite grains while cooling between A_r and A_c .

Howe's assumption that ferrite is rejected to austenite grain boundaries in cooling steel, so vigorously attacked by Giolitti, does not involve any assumption of permanency of grain sizes and forms. On the contrary, such influences as coalescence of small austenite grains above A_c , constantly shifting temperature gradients and disturbances caused by non-metallic inclusions produce a state of unrest and continual shifting of high- and low-carbon areas, so that new grain systems are produced upon each reheating. But when this state is finally interrupted by cooling past A_r , ferrite will be rejected first where its concentration is highest and where disturbances produced by soluble impurities are first felt. This should give rise to a network structure, bounding austenite grains in general, but with its location modified by inclusions, whose influence can never be eliminated entirely. In addition to this network, certain ferrite grains will nearly always appear within pearlite, where zones of segregation due to inclusions or to other causes are too far from the low-carbon borders to cause a shift of the ferrite network.

ANOMALOUS BEHAVIOR OF NICKEL AND MANGANESE

In the second paper upon the subject of inclusions (to which reference has already been made) it was shown that nickel and manganese, migrating into carbon steel, resemble many of the other elements in inducing ferrite segregation in the regions thus invaded.

This is an effect that at first appears to be inconsistent with the property usually attributed to these metals of lowering the transformation points of steel. If the temperature represented by A_r , for a steel of given carbon content, is thus lowered, one would ordinarily interpret the action as that of increasing the ferrite solubility in austenite. In a steel containing segregated nickel or manganese it would then appear reasonable to expect that ferrite would separate in these centers of contamination last, instead of first, as the steel cools, which would then leave them in pearlite grains. This is directly contrary to the observed facts.

We are unable to explain this apparent anomaly upon the basis of any direct experimental evidence, but we offer the suggestion that the localized ternary alloy produced by the invading metal, existing in direct contact with the binary solution, produces a system analogous to that of two dissimilar and immiscible solvents containing a common solute, in which the distribution ratio is not unity. Considered as the solvents in question, of course neither the iron-nickel nor the iron-manganese alloy is immiscible with iron above A_c , but the comparatively low mobility of manganese and nickel has the same effect as immiscibility, except in the case of protracted heat-treatments. If we may suppose that the distribution ratio for carbon in the two solvents (iron and iron-nickel or iron-manganese) is such as to cause a recession of carbon from the region invaded by the added (or segregated) metal, the transformation point of the system in this region will be the resultant of two opposing effects: (a) Lowering, primarily due to the formation of the ternary alloy, and (b) raising, due to the diminished carbon content. It is conceivable that the latter effect may be more pronounced than the former, the net result in a cooling steel then being that the system existing at centers of contamination will be the first to reach A_c , and that ferrite will be generated first in these regions.

This hypothesis is offered with some degree of hesitancy and it is to be regarded at present as merely suggestive and as subject to possible revision in the light of data yet to be obtained. The first part of the assumptions involved, having to do with the distribution ratio of carbon, is substantially the same as that offered by Stead to explain the effect of segregated phosphorus. In his paper on the effect of phosphorus upon ferrite crystallization (*loc. cit.*) Stead reasoned that the "solid solution pressure" of carbon is lowered by the presence of phosphorus, with the result that carbon recedes from the regions of phosphorus segregation, the low-carbon austenite breaking down upon cooling, before the main body of the steel has reached its own transformation point.

CONCLUSIONS

It is believed that the influence of non-metallic inclusions upon ferrite segregation in slowly cooled hypoeutectoid steel is principally due to the fact that the inclusions are centers of contamination for the steel mass rather than to any connection between dissolved gases and the state of oxidation of the inclusion. The development of colored halos surrounding many of the inclusions of a polished steel or iron section, and of similar rings when such a section is treated with antimony tartrate solution, indicates the correctness of this assumption. Howe's hypothesis with respect to ferrite genesis is regarded as being correct, except for steels during their first cooling from the liquid state.

Dry Lime-Sulphur and Sulphur Dust Explosions

BY PAUL W. EDWARDS

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PRACTICALLY any combustible dust will explode with violence, under favorable conditions, when mixed with the proper proportion of air and ignited by a flame or spark.¹ Investigations have been made by the Bureau of Chemistry of several recent explosions during the manufacture of dry lime-sulphur, an insecticide, and the grinding and collecting of powdered sulphur. Six men were seriously injured in one explosion in a plant grinding and collecting powdered sulphur.

Dry Lime-Sulphur

The following spray-drying process is used in an insecticide plant: The lime-sulphur solution is pumped from an adjoining plant to a large steel storage tank and it is then sprayed into the drier house. This drying chamber is approximately 18 ft. wide by 12 ft. deep by 12 ft. high, and below it are three hoppers equipped with a screw conveyor for collecting and discharging a large part of the dried product. Hot air, heated by means of a direct oil-fired furnace, is used as the drying medium. The products of combustion and the air used for drying are mixed and passed through a cyclone separator for the purpose of separating from the hot-air current incompletely burned particles of oil or carbon before they reach the drying chamber. Laden with dust, the air leaves the drying chamber through the sheet-metal ducts connected with the inlet of the suction-filter type collector, from the outlet of which the connection is made to the fan which induces the flow of air.

The dust collector consists of several vertical cylindrical compartments arranged side by side, each containing twelve bags for the collection of the dust. These bags are suspended at their closed ends at the same height in the compartment and are so spaced as to provide ample air channels between the individual bags and between the outer bags and the wall of the compartment. Metal rings are attached to the bags at intervals throughout their length, to keep the bags from collapsing during operation.

The dust-laden air entering near the bottom of the collector is compelled to make a turn in coming into the open lower ends of the bags. This has a tendency to make the heavier particles of dust drop into the hopper at the bottom of the collector. The bags are made of a special porous cloth suitable for holding the dust and permitting the purified air to pass through into the surrounding compartment. While the dust is being collected, the air enters the lower end of the bags, passes through the cloth and out to the fan. During the process of cleaning, a valve on the top of the collector opens, permitting a counter-current of air from the fan exhaust duct to pass from the outside to the inside of the bags and thence into the adjoining compartments. At the same time the bags are shaken violently several times. This cleaning process takes place in each compartment successively about every 2½ minutes.

FIRES AND EXPLOSIONS

The first fire is thought to have started in the drying chamber, after the plant had been in operation for about

6 hours. The second fire occurred in the drying chamber after the plant had been in operation for 6 hours. The third fire, accompanied by an explosion, or explosion accompanied by fire, occurred after the plant had been in operation and seemed to start in the upper effluent duct. This fire occurred after a continuous run of 78 hours, during which period a large quantity of product had accumulated in the drying chamber and in the upper and lower effluent ducts, where the air velocity was not sufficient to keep the dry product in suspension. After the plant had been in operation for 61 hours, then idle for 28 hours, during which period the accumulation of the dry powder was permitted to remain in the drying chamber, and had again been put in operation for a short time, the fourth fire occurred.

The fifth fire or explosion evidently started in the dust collector, as it was confined entirely to the dust collector and the duct work connecting the dust collector and the fan, the return air duct from the fan to the dust collector, and the discharge duct from the fan through the ventilator on the roof of the building.

CAUSE AND PREVENTION

It is reasonably certain that the first and second fires were caused by particles of burning oil or carbon from the combustion chamber. The combustion chamber was elevated and placed in a direct line with the main air intake trunk of the drier and it was known that particles of burning oil or carbon from the combustion chamber were entering the drier. The color of the product at that time was changed to a greenish hue, owing to the carbon which it contained. After these fires occurred a cyclone dust collector was installed between the combustion furnace and the drying chamber to remove the fine granular particles of carbon, and the finished product no longer has the greenish hue which it had before the cyclone collector was installed.

The causes of the third and fourth fires and of the first and second explosions have not been definitely determined. They may have originated from any one of the three possible sources: First, discharge of static electricity; second, sparks from oil-burning furnace; third, friction sparks due to presence of steel, wire, nails, bolts, etc., in the conveyors. The presence of hydrogen sulphide and a chemical reaction generating enough heat to ignite the gas was considered a probable cause. It proved, however, to be an improbable rather than a probable cause.

This dry lime-sulphur has the following approximate chemical composition:

	Per Cent
Calcium polysulphide	75
Calcium thiosulphate	5
Free sulphur	8
"Inert" ingredients	12

L. J. Trostel, in the dust explosion laboratory of the Bureau of Chemistry, found that a 75 mg. sample of this dry lime-sulphur generated a pressure of 5.7 lb. per sq.in. when ignited in a 1,500-c.c. flask, as compared with 12.7 lb. per sq.in. for cornstarch, 11.2 lb. per sq.in. for wheat flour, and 10.1 lb. per sq.in. for Pittsburgh standard coal dust. The ignition point of dry lime-sulphur was found to be between 275 and 300 deg. C. The ignition point of sulphur is 261 deg. C.,² and of hydrogen sulphide 364 deg. C.³

This would seem to eliminate the theory that the explosion was caused by the ignition of hydrogen sulphide,

¹"Dust Explosions," Price and Brown, Nat. Fire Prot. Assoc., Boston, July 1922.

²Dictionary of Applied Chemistry, Thorpe, Vol. V, p. 297.

³Dixon and Coward, *Trans., The Chem. Soc.*, vol. 95, p. 517.

TABLE I—STATIC VOLTAGES NOTED ON DUST COLLECTORS IN STARCH FACTORY

A Stocking Not Grounded	B Stocking Grounded With Wire To Rings Only	C Stocking Grounded By Wire Sewed to Seam of Bag	Remarks
0	0	0	Before starting
1 10,000+max. 1,000 ave.	1,000	0	No starch, cold air blown through collector
2 2,000	1,000	0	No starch, hot air blown through collector
3 0-500	0-200	0	50 per cent full load starch
4 4,000 ave. 3,500-4,500 limits	2,300 2,300	0	75 per cent full load leav- ing. Temp. 165 deg.
5 4,500 ave. 1,500-5,000 limits	2,300	0	Full load leaving. Temp. 165 deg.
6 10,000+ Average*	4,500 ave. 5,000 max.	0	Later reading same as (5)

A—Wire to electrometer connected to stocking at a point midway between rings.

B—Wire to electrometer connected to stocking at a point midway between rings and on opposite side of bag from ground wire.

C—Wire to electrometer connected to stocking at a point midway between rings and on opposite side of bag from ground wire.

* Wire to electrometer connected to ring of stocking.

the ignition temperature of which is higher than that of either dry lime-sulphur or pure sulphur. The general opinion is that the fifth fire was caused by a static spark. Everyone concerned was particularly interested in the cause of this fire, because it occurred in the dust collector, a number of which are already installed in the starch, milling and other industries. It is of vital importance that the hazard of explosions and fires be reduced to a minimum in this equipment.

Dr. W. A. D. Rudge⁴ has shown that any dust blown in a cloud imparts a charge of static electricity on each dust particle, the polarity and size of the charge depending upon the chemical composition and fineness of the material. Sulphur and the sulphides when blown in a cloud carry very strong charges of positive static electricity. Since this particular grade of dry lime-sulphur contained about 75 per cent of calcium polysulphide and 8 per cent of free sulphur, it was concluded that a static charge of high potential must be accumulating on the bags of the filter type dust collector, owing to the fact that large quantities of dry lime-sulphur were being blown from the drying chamber to the dust collectors.

Some preliminary readings were made with an electrometer to determine the difference of potential between the filter bag and the shell of the collector which had been thoroughly grounded. In some readings the static voltage exceeded 20,000 volts. It was found that by grounding one of the rings of the filter bag through a copper wire, the static voltage would be decreased to 3,300 volts. The manufacturer had placed steel chains from one end of the filter bags to the other, and had attached both ends to the shell of the collector as a means of grounding the filter bags. As a grounding medium the chain was very inefficient, owing to the high resistance between links of the chain and to inadequate contact with the bags. Under the circumstances it would appear that the high electrical resistance of the chain was a fortunate condition; otherwise, static sparks would have passed from the filter bag to the chain in a very dusty atmosphere, causing explosion or fire.

TESTS FOR STATIC ELECTRICITY

To obtain additional information on static electricity formation and to devise definite methods of control, a complete test was made on a similar equipment used

in the manufacture of starch (See Table I). In compartment A the filter bag was not grounded and the wire to the electrometer was connected to the bag at a point midway between rings. In compartment B the bag was grounded with braided copper wire attached to all rings and to the top and bottom of the shell of the collector. In compartment C the bag was grounded with braided copper wire, sewed to the seam of the filter bag and both ends of the wire were thoroughly grounded to the shell of the collector.

The results of these tests showed conclusively that bags not properly grounded carried a high-voltage static charge while in operation, this voltage in some cases evidently exceeding 25,000 volts. In compartment B, where the grounding wire was attached to the rings of the filter bag, the charge was not completely carried off, a maximum of 5,000 volts being recorded in the last test. In compartment C, where the grounding wire was sewed to the seam of the bag, however, the bag was completely grounded. The electrometer in each of the six tests did not register any voltage.

A very interesting phenomenon was observed in the two cases where the filter bags were not thoroughly grounded. The instant the counter-current of air stopped flowing, the static charge would increase gradually until the bag started to shake, then drop to approximately 2,000 volts and remain there until the counter air current came on, at which time it would immediately drop to zero. This would seem to indicate that the charge which each particle of dust carried was not deposited on the bag, but was retained by the starch. In the sixth test, the wire to the electrometer was attached to one of the rings of the bag which was not grounded in compartment A. In this case the average reading was over 10,000 volts, showing that a high difference in potential existed between the ring and shell of the collector.

TABLE II—STATIC VOLTAGES NOTED ON DUST COLLECTORS IN DRY LIME-SULPHUR FACTORY

A Chain in Stocking	B Chain in Stocking	C Wire Sewed On Bag	D Wire Sewed On Bag	E Chain in Stocking	Remarks
1 0	0	0	0	0	Not in operation
2 0	0	0	0	0	Cold air only
3 0	0	0	0	0	Temp. 122 deg. F
4 0	0	0	0	0	Temp. 173 deg. F
5 1,300	400	0	0	0	Spraying started Collectors not shaking
6 0-5,000	0-2,000	0-200 (?)	0	0	Collectors shak- ing
7 10,000+	10,000+	200	0	3,500	Collector door open
8 4,500	0-1,500	0	0	200	Collectors shak- ing. Temp. 196 deg. F.
9 10,000+	10,000+	0	0	2,000-3,000	Collector door open. Temp. 196 deg. F.
10				0	Collector shaking
11				0	Open door

A—Steel chain through center of bag grounded to shell of collector. Wire to electrometer connected to first ring at bottom of bag.

B—Steel chain through center of bag grounded to shell of collector wire to electrometer connected to two copper wires placed around bag at first and second rings, copper wires connected electrically.

C—Braided copper wire sewed to bag along lengthwise seam. Wire to electrometer connected directly to bag at a point midway between bottom of bag and first ring and on side opposite to seam.

D—Braided copper wire sewed to bag along seam. Wire to electrometer connected to bag at a point midway between first and second rings and on side opposite to seam.

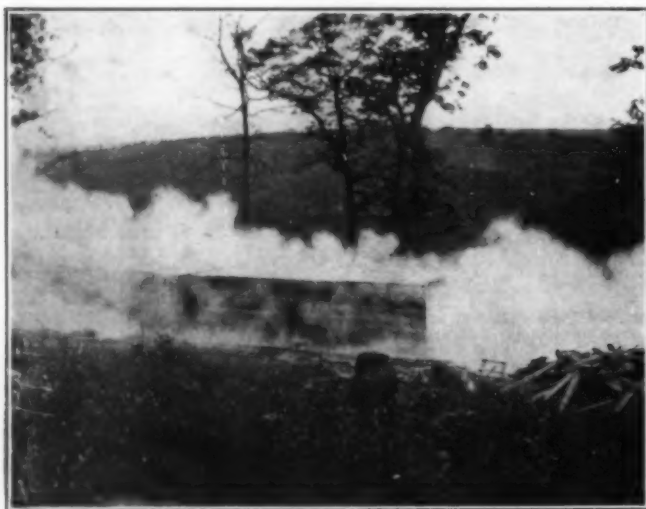
E—Steel chain through center of bag grounded to shell of collector. Wire to electrometer connected to steel chain.

⁴Phil. Mag., vol. 23, p. 852 (1912), and vol. 25, p. 481 (1913).

A complete test was then made on the equipment used in the manufacture of dry lime-sulphur (Table II). These tests were made on one bag in each of five different compartments and under nine different conditions or phases of operation. In compartments *A*, *B* and *E* the test was made with a steel chain through the center of the bag. This was the method that had been used to ground the bags. In compartment *C* the braided copper grounding wire was sewed to the bag along the lengthwise seam, and both ends of the wire were grounded to the shell of the collector. It was known that the shells of all the collectors were thoroughly grounded. The wire to the electrometer was connected to the bag at a point midway between bottom of bag and the lower ring, and on the opposite side of bag from ground wire. In compartment *D* braided copper grounding wire was sewed to the seam of the bag and the wire to the electrometer was connected to the bag at a point midway between the first and second rings and on the opposite side of the bag from the ground wire. The wire to the electrometer in compartment *E* was connected to the steel chain.

No static charges were observed under the first four conditions of test—namely, when the plant was not in operation, when cold air was blown through the whole system, when air at 120 deg. F. was passed through the system and when air at 173 deg. F. was passed through the system. In test 5, where spraying had begun but the collectors were not shaking, static charges were observed on bags inadequately grounded by means of steel chains. In test 6, when the collectors were shaking, the static voltage increased almost instantly to a maximum of 5,000 volts on a bag which was inadequately grounded. It will be noted, however, that no static charge was registered on bags which were grounded with braided copper wire sewed to bag. In the seventh test, as soon as the door at the bottom of collector was opened, the electrometer registered a violent deflection over the graduated scale of the electrometer. This voltage was estimated at between 20,000 and 30,000 volts. In compartments *C* and *D* the ground wire carried off all charges. The remaining tests were repetitions of the preceding tests, for which they served as a check.

These results proved conclusively that under certain conditions extremely high static charges were generated and that these charges can be entirely eliminated by properly grounding the filter bags in the dust collectors.



SULPHUR DUST EXPLOSION IN EXPERIMENTAL GALLERY

Probably the most interesting phenomenon observed while making the tests was the fact that dry lime-sulphur builds up its static charge in a manner directly opposite to that of starch. In collecting dry lime-sulphur, a very small charge was observed when the bags were not shaking, but as soon as the shaking started it immediately built up to 5,000 volts in the bags which were insufficiently grounded with chains. When the door at the bottom of the collector was open, the voltage on these bags built up instantly to probably 20,000 or 30,000 volts, which is the reverse of the action of static charges on bags which were collecting starch dust.

Some tests were made to determine why the static charges on the filter bags collecting dry lime-sulphur did not build up gradually in the same manner that the static charges built up when collecting starch. A small installation similar to the dust collectors described was made. The filter bags were made from the same material as those used for collecting dry lime-sulphur and starch. The bags were insulated from the duct. The powdered lime-sulphur was passed through this collector at a constant rate and it was found that a static charge built up gradually to a maximum of 4,800 volts. The same condition was noted when a starch was used instead of dry lime-sulphur. It will be noted that the building up of the static charge when using dry sulphur in this test was similar to the way the charge built up in the starch collectors, and the reverse of the conditions observed in the dry lime-sulphur collectors. Since it was impossible to duplicate the static conditions as found in the dry lime-sulphur plant, it seems very probable that the difference in conditions was caused by the grounding chain used in the collectors at that plant. It was also discovered that dry lime-sulphur readily attacked the braided copper grounding wire. It is recommended that aluminum, brass, lead or steel grounding wires be used instead of braided copper wire.

Sulphur Dust Explosion

A disastrous explosion occurred recently during the collecting of powdered sulphur in the grinding section of a chemical plant. In this explosion six men were seriously injured. The equipment for grinding and the separation of the different sized particles of sulphur had been designed to operate continuously. Owing to the fact that several fires had occurred in the grinder, the grinder was operated only part of the time and the ground sulphur was bagged. The grinder was then stopped and the ground sulphur was dumped into the suction type pneumatic separating system. The sulphur was passed through a cyclone dust collector, where all particles less than 200 mesh were removed. The rest of the sulphur was carried to a filter type dust collector, where it was removed.

According to a number of workmen, the explosion occurred at the bottom of the filter type dust collector. The explosion propagated through one section of the filter type dust collector, then through the main trunk into the cyclone collector, which was completely destroyed. The explosion propagated from the cyclone collector through the trunking system to the point where the sulphur was being fed into the main trunk, at which point several feet of trunking were destroyed. An investigation showed that one end of the screw conveyor under the filter bag dust collector had become loosened. The probable cause of this explosion was the rubbing of the loose end of the conveyor on the metal jacket which produced sparks that caused the initial explosion. The explosion may have been caused by

static sparks discharged from the bag of the dust collector to the shell or hopper of the collector, and this initial explosion may have also loosened one end of the screw conveyor.

The photograph shows a sulphur dust explosion in the experimental gallery of the Bureau of Mines at Pittsburgh, Pa.

To prevent dust explosions caused by static electricity, it is essential to ground thoroughly all equipment on which charges of static electricity may be generated or accumulated. There are on the market several very efficient static detectors which can detect a difference of potential as low as 300 volts. These are valuable not only to detect static charges but also to make certain that the charges are being carried off after the equipment has been grounded.

Leaching Copper Ore With SO_2

A FEW years ago members of the Bureau of Mines experiment station at Tucson, Ariz., under the direction of C. E. van Barnevelt, made some tests on car-load shipments of mill tailings and crude ores from that vicinity, having in mind the possibility that leaching by SO_2 might be utilized to increase the copper recoveries. So much success attended their efforts that the Miami Copper Co. built a 100-ton SO_2 -leaching plant which was operated intermittently during 1919 and the early portion of 1920 under the personal direction of a member of the Tucson station staff. The feasibility of SO_2 -leaching on copper oxides, carbonates and finely disseminated metallic copper was fully demonstrated. Certain silicates of copper occurring in the Miami ore in the form of a dilute solution of copper silicate in quartz proved quite refractory. Sulphuric acid appeared to dissolve these silicates much more readily. The SO_2 -leaching plant at Miami was closed at the end of February, 1920.

When the Bureau of Mines entered the copper-leaching field the New Cornelia leaching plant at Ajo was in operation. The designers of this plant took advantage of all the accumulated knowledge on the subject of sulphuric acid-leaching and copper-refining practice and utilized the best available engineering ideas to design and build a 5,000-ton leaching plant for the treatment of their oxidized ore. Difficulties developed in the operation of the plant, attributable to soluble impurities in the ore, principally iron. An intermediate reduction process was installed to reduce the ferric iron to the ferrous condition. This alleviated but did not cure the trouble, and there is still a considerable loss of electric current. However, the New Cornelia plant was considered not only a commercial success but a decided advance on former practice. The recovery of copper ranges between 80 and 85 per cent. Three-quarters of the copper recovered is electrolytic copper and the remainder cement copper.

Coincident with the experimental work at the Miami Copper Co.'s mill, the Inspiration Copper Co. erected a 30-ton experimental sulphuric acid-leaching plant. The two mines adjoin and the ores are very similar. The Inspiration ores have the advantage over New Cornelia ores in that the amount of soluble iron is negligible. The Inspiration research staff did not venture afield outside of known practice. They did, however, take full advantage of available knowledge on the subject, with the result that they greatly simplified procedure and worked out what appears to be a highly efficient and economical sulphuric acid-leaching process.

Decided advance was made in electrolysis. The absence of impurities in the ore permits the use of a very low electrolyte containing around 1 per cent copper, as against 3 per cent copper at New Cornelia. Furthermore, it was found possible to strip the discard solutions by electrolysis, thus avoiding the necessity of precipitation on iron, the entire product being electrolytic copper.

The great improvement of Inspiration results over New Cornelia results interested the Miami Copper Co. to the point of deciding to undertake similar experiments on its ores, with this modification: It was proposed to leach finely ground ore (48 mesh) as against coarse ore ($\frac{1}{4}$ in.) at Inspiration. This involved investigating the possibilities of filtration of acid pulp, and it was decided to close down experimental work on SO_2 leaching. The Miami sulphuric acid experimental leaching work has not been brought to a conclusion, though the experimental plant is temporarily closed.

In the meantime a small-scale pilot drum has been constructed at Tucson which has been developed to the point where it permits very nice control of all the variable factors. The apparatus not only gives qualitative results but gives a very dependable quantitative index. Recently, a decided advance has been made in the dissolution of the hitherto refractory silicates so that the SO_2 -leaching process compares favorably with the best sulphuric-acid leaching results reported on these ores.

In 1920 the Arizona Copper Co. erected a 25-ton plant at Clifton for leaching copper ores with SO_2 . This plant began operations on June 1, 1920, and was closed down on April 15, 1921, in conformity with a rigid policy of retrenchment which resulted in closing all the Clifton operations. The Clifton work to date has fully demonstrated the applicability of SO_2 leaching to these ores. The average extraction by SO_2 about equals extractions obtained on parallel sulphuric acid work. On ores having high acid-soluble gangue content, SO_2 -leaching results are particularly favorable. Former sulphuric acid-leaching tests on this material indicate a consumption of 8 lb. of acid per pound of copper recovered, equivalent to an acid cost of 4c. per pound of copper. It is estimated that the ratio of sulphurous acid (H_2SO_3) to sulphuric acid (H_2SO_4) required is 1.5 to 1 and that sulphurous acid can be made by roasting local concentrates, at about 0.06c. per pound, which is practically one-tenth the cost of sulphuric acid figured at \$10 a ton. The reagent cost in SO_2 leaching would therefore be only 15 per cent of the reagent cost in sulphuric-acid leaching.

Manufacture of Salt in 1921

Census reports show a decrease in the activities of the establishments engaged in the manufacture of salt during 1921 as compared with 1919. The total value of products reported for 1921 amounted to \$32,539,107, and for 1919 to \$37,513,821, a decrease of 13.3 per cent. There were corresponding decreases in the number of persons employed and in the amount paid during the year for salaries and wages, but there was a slight increase in the cost of materials. Michigan, the leading state in the industry in 1921, produced 31.3 per cent of the total value of products in that year.

The combined output of all establishments was approximately 66 per cent of the maximum capacity, based upon a demand requiring full running time.

Synopsis of Recent Chemical & Metallurgical Literature

Inclusions and Ferrite Crystallization in Steel

Experiments with an open-hearth rail (analysis: C 0.55, Si 0.06, P 0.014, S 0.13, Mn 0.85 per cent) are recorded by E. G. Mahin.¹ Microscopic examination showed a banded ferrite structure, with many inclusions thought to be manganese sulphide. A cupric reagent also shows excessive phosphorus banding. This steel, when quenched from above the transformation range, showed uniform martensite—evidently slow cooling is necessary for the accumulation of ferrite, a conclusion verified by quenching samples which were furnace-cooled to various temperatures in the transformation range. The first ferrite to appear borders inclusions. However, inclusions and their ferrite shells are located indiscriminately within and without phosphorus bands.

Another sample heated for 3 days at 1,100 deg. C. under fusible glass revealed neither ferrite nor phosphorus banding in transverse or longitudinal directions. The heat-treatment coarsened the grain enormously, but did not affect the location and shape of the inclusions, nor the fact that they were still surrounded by ferrite.

Mahin concludes that while phosphorus is largely responsible for the existence of ferrite bands after ordinary heat-treatment, as held by Stead in several papers before the British Iron and Steel Institute, this is certainly not the reason for the persistence of ferrite shells about the inclusions, remaining even after long heating under carbonizing conditions.

To substantiate his hypothesis that this persistent structure was due to traces of the inclusions (or the products of the reaction which formed it) existing in a small volume of the surrounding steel, Mahin and Hartwig conducted further experiments.² A bar of rolled carbon steel containing 0.53 per cent of carbon was cut into disks 1 in. thick. These were drilled with $\frac{1}{8}$ -in. holes, using no lubricant. Clean rods, slightly oversize, of various metals, were then driven into these holes, and the plugged disk heated in a closed muffle at 850 deg. C. for 7 hours, cooling in the furnace. Alloys such as aluminum bronze, white metal, die-casting alloy, stellite, high-speed steel, manganese steel, chromium steel and nickel steel were used for plugs. Heat-treatment always produced a band of ferrite of greater or lesser thickness in the carbon steel at the

junction. The conclusion is set forth that certain chemical elements of the high-alloy insert diffuse across the junction, enriching the carbon steel in that immediate neighborhood and so disturbing the solubility of carbon in austenite that ferrite precipitates in those impure portions somewhat above the normal recalescent temperature. This first ferrite to appear acts as a nucleus of crystallization and attracts a considerable mass of ferrite, forming subsequently.

Oxidation is held to have no influence on this decarbonized ring for several reasons. Ferrite production seems to be a minimum where contact between plug and carbon steel is poorest. The insert is never decarbonized. Furthermore, the action is too extensive to be referred to the minute amount of oxygen which could be retained. (In fact, pearlite grains reach the borders of actual cavities found at the junction, any carbon removed by gas being apparently replaced by diffusion.) Likewise, a high-phosphorus steel plug will produce a high concentration of phosphorus in the carbon steel, as can be shown by Stead's reagent. Finally, some inserts have given no ferrite bands.

That diffusion is easily possible across the junction is shown by the fact that a plug of Armco ingot iron shows a ferrite band on the sheath and pearlite at the plug.

Finally, in another paper,³ Mahin and Brewer show that the electrode potential of the ferrite shell is 0.471 volt, while a corresponding value for ferrite in the unaffected body of the carbon steel is 0.522 volt. This is further evidence that the shell is more impure than the main body.

Doherty Washer-Cooler as a Water-Gas Condenser

In a paper presented at the 1922 convention of the American Gas Association at Atlantic City, F. W. Steere, of Detroit, Mich., described the use of the Doherty Washer-Cooler as a water-gas condenser. The Doherty Washer-Cooler method of direct condensation he defined as the process of cooling gas by bringing it in direct contact with its own recirculated condensate, the heat from the condensate being removed before recirculation. The apparatus required is a gas-tight tower with nozzles and connections, a spray-header for distributing the recirculated liquor, grids for bringing about contact between the gas and the liquor, a continuous tar and liquor overflow, a pump

for recirculating the liquor, and cooling coils, or other means, for removing the heat from the recirculated liquor.

The gas to be cooled enters the washer-cooler tower at the hot gas inlet and passes upward through the grids in direct contact with the recirculated liquor. This recirculated liquor, after cooling, is sprayed over the grids at the top of the tower and runs by gravity over the surface of the grids to the bottom of the tower, where it is collected in the reservoir in the base.

In the theoretical ideal machine, the recirculated liquor in the base of the tower would be raised to the temperature of the incoming gas, and the gas at the outlet of the tower would be cooled to the temperature of the recirculated liquor at the top of the tower. Local conditions determine how close to these figures it is practical to go.

DATA REQUIRED FOR WASHER-COOLER DESIGN

The success of the washer-cooler depends on the accuracy with which every part is designed and proportioned for the particular problem in hand. There is no such thing as a standard plant. This is obvious from the varying nature of the conditions encountered in every locality. The tendency in designing gas-works equipment is usually to "play safe." This invariably results in an unbalanced plant and an excessive charge for power and maintenance. Gas saturated with water vapor contains a known quantity of heat at all temperatures and the removal of this heat from the gas and its subsequent dissipation is all susceptible to very accurate figuring.

To determine the maximum demand on the washer-cooler, it is essential to have the data on two conditions—

First, The demand on the plant during the period of highest cooling water temperatures.

Second, The maximum hourly demand on the plant.

With these points determined, it is possible to design a condensing plant which will reduce the temperature of the gas to the lowest temperature possible under prevailing conditions.

SATURATION TEMPERATURE

The real problem in cooling gas is not in cooling the gas itself, but in removing the heat carried by the water vapor. It is of the greatest importance that fairly accurate information be available on the water vapor saturation temperature of the gas to be cooled. Observations indicate that the saturation temperature of water-gas rarely exceeds 185 deg. F.

In water-gas plants it is found more suitable to locate the washer-cooler tower after the relief holder and get the benefit of the atmospheric cooling resulting from the high temperatures in the relief holder. The importance of this is evident because 22,400 B.t.u. must be removed per 1,000 cu.ft. of gas in reducing a saturated gas from 190 to 185 deg. F. This is almost as much heat as must be removed in cooling

¹J. Ind. Eng. Chem., vol. 11, p. 739 (1919).

²J. Ind. Eng. Chem., vol. 12, p. 1019, (1920).

³J. Ind. Eng. Chem., vol. 12, p. 1095 (1920).

1,000 cu.ft. of gas from 160 deg. down to 90 deg. F.

Another advantage of placing the washer-cooler tower after the relief holder is obtaining a uniform flow through the condensing system without the variations resulting from the intermittent nature of the water-gas process.

WASHER-COOLER TOWER

The diameter, or cross-sectional area, of the washer-cooler tower cannot be figured until the design of the grids is determined. The space in the tower which is occupied by the grids reduces the gas capacity or the available cross-section of the tower to the extent of their volume. The grids, for this reason, should have the lowest possible volume in proportion to their surface.

Properly designed board grids have been found most effective for use in the washer-cooler tower. The grids must be constructed to have sufficient mechanical strength to support their weight after becoming waterlogged and to eliminate the possibility of their squashing over and closing off the gas passages. The bottom edges of the grids should be serrated to insure a uniform distribution of the cooling liquor throughout the entire height of the machine. The importance of keeping the entire surface of the grids uniformly wetted cannot be overemphasized, as dry surfaces will tend to accumulate solid matter.

With $\frac{1}{4}$ -in. grids spaced $\frac{1}{2}$ in. apart, the washer-cooler tower should have a minimum cross-sectional area of 1 sq.ft. for each 8,300 cu.ft. of gas passed per hour. A vertical height of 30 ft. of grids is about the minimum that can be used to bring about a complete heat transfer between the cooling liquor and the gas and at the same time thoroughly scrub the gas. These figures do not apply to volumes less than one-half million cubic feet per 24 hours, nor for handling gas through extreme temperature ranges.

DISTRIBUTING LIQUOR OVER THE GRIDS

Since the gas outlet is at the top of the washer-cooler tower and the cooling liquor is introduced at the top, any tendency to fog the liquor as it enters the tower will result in an excessive carrying over of the liquor with the gas. The best design of spray header distributes the liquor over the entire cross-section of the machine as nearly as possible in the form of a rain, the larger the drops the better. The nozzles delivering the liquor should be placed below the level of the gas exit.

COOLING COILS

The first factor to be determined in cooling coil design is the rate at which heat is transferred through the walls. This, of course, depends somewhat on the design; but in any design the laboratory figure for the rate of heat transfer is higher than the figure which should be used for commercial operation. Experiments lead us to believe that a heat transfer of 1 B.t.u. per minute per square foot per degree of mean temperature difference is a safe

figure for commercial operation. It must be noted that this figure is based on the mean temperature difference and not on the average temperature difference.

Cooling coil stacks may be either single-pipe or double-pipe. The liquor usually passes through the coils in single-pipe stacks and the cooling water over the outside. Double-pipe stacks are made by putting one pipe inside the other, with the liquor to be cooled passing through the annular space between the pipes. The cooling water flows through the inner pipes and over the outer pipes. The double-pipe stack is not recommended for water-gas cooling, as it is more liable to stoppage and not as accessible as the single-pipe stack.

In the ideal stack, using the counter-current principle of heat transfer, the cooling water is raised to the temperature of the liquor to be cooled as it leaves the bottom tube, and the liquor is cooled to the temperature of the cooling water. If the stack is too high, the lower pipes of the stack are inoperative, as this temperature equilibrium has been attained before the cooling water reaches the bottom of the stack. If the stack is not high enough, the cooling water leaves the stack before it has been raised to the temperature of the incoming liquor.

The heat can also be taken from the recirculated liquor by passing it over the cooling coils instead of through the cooling coils. This requires an extra pump unless the cooling coils can be placed at a sufficiently low elevation so that the hot liquor can run over the coils by gravity. The cooling water is then run through the coils and this heated water, under pressure, can be utilized for other purposes without repumping.

When the cooling water passes over the coils, there is also a cooling of the cooling water resulting from evaporation. Under conditions of low humidity, this atmospheric cooling may amount to as much as 25 per cent of the total cooling. It should not, however, be taken into account in the calculations for those parts of the world where high humidity and high atmospheric temperatures may occur simultaneously.

ATMOSPHERIC COOLING

The heat may be extracted from the cooling liquor by atmospheric cooling. This may be done either in an atmospheric type of cooling tower, in a forced draft type of cooling tower, in a cooling pond or in a combination of these schemes which may fit in with local conditions.

With cooling coils, a washer-cooler tower with the smallest possible cross-sectional area should be always used. This means a lower first cost, and at the same time insures the highest possible heat transfer efficiency. With atmospheric cooling, a larger and more expensive washer-cooler tower is desirable and in many cases necessary. The reason for this is obvious when we recall that a given quantity of liquor

is required to wet the grids irrespective of the quantity which may be required to take up the heat in the gas. If the cross-section of the washer-cooler tower is increased, thereby increasing the quantity of liquor required to wet the additional grids, the liquor at the bottom of the tower will be at a proportionately lower temperature, because there is more of it to absorb the same quantity of heat. The mean temperature difference, therefore, between the liquor to be cooled and the cooling medium is correspondingly lower. When cooling coils are used, this condition is serious, as there is a direct relation between the cooling surface required and the mean temperature difference. With atmospheric cooling of the recirculated liquor, the lower temperature of the liquor to be cooled is an advantage. This follows from the fact that as the temperature range through which the liquor must be cooled increases, the expense of the equipment and cost of power rapidly increases.

With atmospheric cooling, there is no cooling water required from any outside source. From this standpoint, atmospheric cooling has a distinct advantage. On the other hand, the mist, saturated with tar and oil vapors, which is given off during the process of atmospheric cooling, carries about the plant and the surrounding district. In spite of the most careful baffling, this at times is very disagreeable. If the plant is located in a settled district, this may result in serious complaints from the neighborhood.

On plants where cooling water is not available in sufficient quantities and where direct atmospheric cooling of the recirculated liquor is objectionable, a very satisfactory combination can be effected by using an atmospheric cooling tower for removing the heat from the water used over the coils. The only cooling water required with this arrangement is the make up to replace that lost by evaporation and windage.

One very interesting fact becomes apparent from a study of any condensing and cooling problem—that is, the key of the design of the entire condensing system is the design of the grids in the washer-cooler tower. This is obvious when we recall that the cross-sectional area of any tower is determined by the proportion between the area occupied by the grids and the free gas passages. The size of the tower, in turn, determines the quantity of recirculated liquor required to wet the grids. The quantity of recirculated liquor determines the temperature to which this recirculated liquor will be raised after passing through the tower. The temperature of the recirculated liquor directly determines the mean temperature difference available for cooling. The mean temperature difference is the factor which determines the number of stacks of cooling coils required. If atmospheric cooling is used, the same argument applies to the range through which the liquor must be cooled.

In conclusion, I might add that pos-

sibly the best proof of the fundamental soundness of this method of cooling and condensing gas is the fact that a great many plants have replaced their tubular condensers with washer-coolers, but I have yet to hear of a washer-cooler being replaced by a tubular condenser.

Rapid Sorting of Alloy Steels

M. Gallibourg presented a note before the French Academy of Sciences (Feb. 6, 1922) in which he proposed to distinguish between steels of equal hardness by measuring their contact e.m.f. against iron. A small pot of mercury, preferably kept at 120 deg. C., is needed. An ordinary galvanometer, potentiometer or delicate millivoltmeter is also required. Electrolytic iron wire is used for leads, the end of one being immersed in the mercury bath, and the end of the other welded to a water-cooled clamp.

Each piece of steel is first tested by the Brinell method and sorted into groups of approximately equal hardness. Every piece of steel of hardness 190-210, for instance, is then tested for contact e.m.f. by clamping each individually in the fixture and immersing the other end into the mercury bath. The latter acts as a heating medium and also establishes a perfect electrical connection. Within a few seconds the electrical indicator reaches equilibrium and a reading is taken. Steels having equal hardness and equal e.m.f. are quite certain to be of the same chemical composition; as a matter of fact, heat-treatment, which affects the hardness greatly, makes little or no change in the electrical characteristics. Only in rare instances would it be necessary to retest a group of steels having the same hardness and contact e.m.f. Such retesting should be done after normalization.

The Influence of Iron on Copper and Copper Alloys

In delivering his address as the chairman to the members of the Birmingham local section of the British Institute of Metals, of Oct. 10, Dr. F. Johnson took as his subject "The Influence of Iron on Copper and Copper Alloys." The following is a summary of the address:¹

Copper—Iron up to 0.5 per cent deoxidizes, toughens and strengthens copper, even in the presence of arsenic. It is very detrimental to electrical conductivity and a very small quantity makes the metal paramagnetic and unsuitable for using in galvanometers. Copper is capable of holding about 3 per cent iron in solid solution.

Alpha Brass—There appears to be an overwhelming weight of opinion in favor of keeping the iron content low—say, 0.1 per cent—for the reasons that it increases (a) the casting difficulties, (b) the power required for mechanical operations, (c) the annealing costs, (d) the corrodibility. For special purposes—e. g., articles required to be stiff

and springy—the addition of iron is advantageous, but it need not exceed 1.0 per cent for these purposes. Advantage might be taken of the influence of iron in raising the annealing temperature of cold-worked alpha brass to increase the convenience of the low-temperature annealing processes for the removal of internal stresses of cold-worked material. A slightly higher temperature of annealing would mean a shortening of the annealing period—an advantage in works practice.

Alpha + Beta Brass—Iron appears to serve a very useful purpose indeed in large castings of this type, particularly in reducing the grain size and improving the strength and toughness. The indications appear to be that the beneficial action is greater in the case of brasses in which the beta phase is in excess, and that 1 per cent need not be exceeded.

Beta Brass—The grain size is reduced, but no improvement in mechanical properties appears to accrue to castings. An improvement, especially in ductility, has been found to occur in the case of hot-forged and rolled bars. This may be due to retardation of recrystallization during the hot-working process.

Nickel Brass (Nickel Silver)—The addition of iron has been specially recommended for cutlery stock and extra hard springs.

Copper - Aluminum (Aluminum Bronze)—Iron up to 4 per cent has been found to be very beneficial in reducing grain size, retarding crystal growth and facilitating the production of die castings.

Admiralty Gunmetal—Iron up to 1 per cent does not appear to be detrimental if correctly alloyed. The mechanical properties are enhanced under such conditions, in the case of small chill castings.

In most of the alloys examined, the limit of solid solubility occurs at less than 1 per cent iron. In brass there are two forms in which the iron exists in excess of that entering into solid solution—viz., (1) As free iron-rich crystallites, globular or cruciform in shape. These are pale blue, but turn black when etched. (2) As very minute uniformly distributed dark-etching particles. As a rule, the beneficial influence of iron ceases at the degree of concentration at which the free crystallites appear.

Heat-Treatment of Gray Cast Iron

It has often been proposed to anneal gray iron castings in order to relieve internal strains and to machine more easily. Aging 2 months or more in the weather is also resorted to—corrosion will eat through hard spots on the skin at the same time.

J. E. Hurst has presented an article in *The Engineer* (July 4, 1919) in which he concluded that Fe₃C in cast iron containing more than 1 per cent Si gradually decomposed at 550 to 600 deg. C., regardless of the amount of

cementite originally contained. Lower silicon irons were found to be very stable.

E. Piwowarsky, in *Stahl und Eisen* (Sept. 28, 1922), took a gray cast iron (combined carbon 2.68, graphite 0.5, silicon 0.07), remelted part with steel scrap (resulting in combined carbon 1.0, graphite 1.5) and another part with 1 per cent Ni. To soften these irons they had to be quickly heated a little above A_{c1} (800 to 825 deg. C.) and cooled at 2 deg. per minute through the transformation—i.e., down to 735 deg. C. Annealing below A_{r1} did not graphitize the carbon.

A second paper in the same issue was written by E. Schütz. He used castings containing (after reheating) 3.1 per cent of graphite, 0.5 per cent combined carbon and 2.3 per cent Si. Such castings varied in Brinell hardness from 126 to 155, surface to center. Cementite in the eutectoid pearlite started to decompose in these castings after 24 hours at 500 deg. C., and the reaction was completed and hardness uniformly reduced to 130 after 3 hours at 650 deg. C., or 24 hours at 600 deg. C.

Importance of Alloy Steels

A striking illustration of the present importance of alloy steels is given in production statistics recently issued by the American Iron and Steel Institute. Despite an extremely low tonnage for the whole industry in 1921, the relative amount of alloy steel remained very close to its record 1919 figure.

TABLE OF PRODUCTION OF STEEL INGOTS AND CASTINGS AND OF ALLOY STEEL INGOTS AND CASTINGS IN THE UNITED STATES. (000 omitted)

	Total Steel, Gross Tons	Alloy Steel, Gross Tons	Alloy Steel of the Total, Per Cent
1909.....	23,955	181	0.75
1910.....	26,094	567	2.17
1911.....	23,676	481	2.03
1912.....	31,251	792	2.53
1913.....	31,300	714	2.28
1914.....	23,513	646	2.75
1915.....	32,151	1,021	3.17
1916.....	42,773	1,362	3.18
1917.....	45,060	1,644	3.65
1918.....	44,462	1,787	4.02
1919.....	34,671	1,481	4.27
1920.....	42,132	1,660	3.94
1921.....	19,743	809	4.10

Spontaneous Hardening During Brinell Test

In a letter to the editor of *The Engineer* (Oct. 20, 1922, p. 408), P. V. Vernon gives some results on various commercial steels. After making the usual test with a 10-mm. ball, he made a second test at the center of the indentation, using a 1-mm. ball. His results follow:

	10-mm. Ball Hardness	Hardness at Center of Impression
Mild steel.....	128	170
0.40 per cent carbon steel....	302	341
0.80 per cent carbon steel....	223	228
Chromium-vanadium steel.....	183	192
Nickel-chromium air hardening steel annealed.....	228	228
Nickel-chromium air hardening steel annealed.....	212	212
Ditto, hardened, 800 deg. C.....	512	512
Ditto, hardened and tempered, 600 deg. C.....	269	269
High-speed steel annealed....	255	285
Ditto, hardened.....	627(±10)	683
Gunmetal.....	80	115
Copper.....	75	80

¹Reported in *The Engineer*, Oct. 20, 1922, p. 412.

Book Reviews

THE MINERAL INDUSTRY DURING 1921.
VOL. XXX. Edited by G. A. Roush
and Allison Butts. Cloth, 6½ x 9½ in.
895 pp. McGraw-Hill Book Co., New
York, 1921. Price, \$10.

It is a favor to the reading public not familiar with it to be informed regarding the "Mineral Industry." It is the only publication of its kind. Its object is the compilation annually of reviews of the progress during the preceding year in the different fields of mining and metallurgy. Authorities in various lines, after the calendar year has been completed and the statistics and data in the various geological and governmental reports are authentic, contribute articles on the general and economic phases of the industry, thus bringing together under about fifty headings, arranged alphabetically, accurate data on the different subjects, which include Abrasives, Fuels, Metals, Jewels, Precious Stones, and covering these both from the production and economic standpoint. The volume is international in its scope.

Engineers, economists and statisticians accept the publication as a matter of course and regularly add it to their library; but because of the fact that it is issued annually and the first cost seems high, its circulation is relatively limited. It is most probable that there are a large number of people interested in metallurgical products who would greatly appreciate such a book if its merits were brought to their attention; in fact, the writer showed this volume to one of the principal purchasers of one of our precious metals who had never seen it and his criticism was most favorable.

The 43 contributors to the volume include professors, statisticians, consulting engineers, government employees and authorities along various lines, the most of them contributing regularly.

The volume is necessarily published somewhat late after completion of the calendar year, as the governmental statistics must be complete and authentic and also because of the time required by the contributors to arrange the subject matter.

The value of a reference book containing accurate statistics and the possible errors that might occur from using one containing preliminary reports as to data is illustrated by the fact that the writer has on his desk an annual publication of metal statistics published early in the year and for which a supplementary report was issued in July, correcting certain annual production figures to the extent of about 6 per cent.

The last volume of the "Mineral Industry" is of great interest at a time when industrial conditions are becoming more normal; it shows the lessening of production of metals and materials which were produced in more than nor-

mal quantities during the war and also shows the increased production of industrial materials used in times of peace. We look forward with interest to the publication of the volume covering the year 1922.

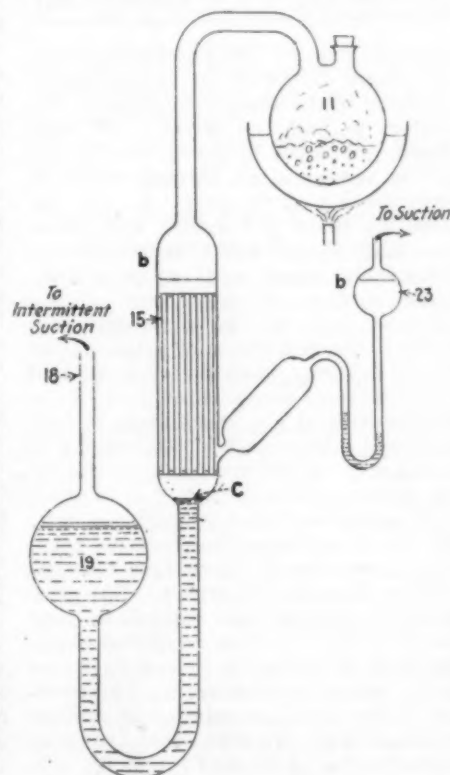
MARSHALL S. WALKER.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Separating Aqueous and Other Vapors From Solids and Fluids—In this patent Dr. Otto Maass, of Montreal, points out that the absorption of water by dehydrators, particularly sulphuric acid, is relatively slow under normal conditions, but if the dehydrators are spread out in thin films, the absorption is extremely rapid. An illustration is given herewith of the laboratory apparatus which was used in this work. The liquid to be evaporated is placed in vessel 11, and vessel 19 contains the dehydrator, in this case sulphuric acid. The principle of operation consists of applying suction at both 18 and 23. First, this causes a diminution in the pressure inside the vessel, then atmospheric pressure is let in at 18, and the liquid rises to a point approximately equivalent to *b* in the diagram. Suction is then applied again at 18, and this draws the liquor down to a point approximately *C*. This acts simply to evacuate the system completely and to saturate the walls and surfaces in vessel 15 with the sulphuric acid. Pressure then becomes



sufficiently low so that evaporation takes place at a very low temperature. This is facilitated by the absorption of the vapor evolved in vessel 15 by the sulphuric acid. The process is repeated as long as desired. The application in industry would consist in the evaporation of substances which require low temperature of evaporation due to their easy decomposition in atmosphere—for example, H_2O_2 . (U. S. Pat. 1,417,618.)

Method of Conducting the Ammonia-Soda Process—Edward E. Arnold and Palmer St. Clair have conceived the scheme of using liquid ammonia and liquid carbon dioxide as cooling media instead of water in ammoniating and carbonating towers. They object to the complicated water piping systems necessary to effect cooling of the ammonia and carbon dioxide absorption processes in the ammonia-soda process for sodium carbonate. A great deal of water has to be used, and in summer, in many localities, this is unsatisfactory, as the water supply is apt to be fairly warm. By introducing liquid ammonia and liquid carbon dioxide, they would materially cut down the quantity of cooling liquor necessary, because the latent heat of vaporization of the two substances would be equivalent to a relatively large quantity of water in producing equivalent quantities of available heat.

An advantage lies in the fact that leaks in the cooling system would have no harmful effect. Take, for example, the cooling of the carbonating towers with liquid carbon dioxide. Suppose there were a small leak in the cooling system. It would mean the escape of small quantities of carbon dioxide gas into a tower in which carbon dioxide gas was being absorbed. The patent has been assigned by the authors to the Nitrogen Corporation of Providence, R. I. (U. S. Pat. 1,423,510. July 25, 1922.)

Making Low-Boiling Hydrocarbons—Benzol, toluol and other low-boiling hydrocarbon oils are the products obtained from various permanent gases in the process patented by Clive M. Alexander and assigned to the Gulf Refining Co. Natural gas, still gases and various other gases made by heating oil, etc., are submitted to a high temperature, specified as 500 to 100 deg. C. and under a pressure of 50 to 100 lb. A molecular rearrangement takes place to form vapors of the low-boiling or liquefiable hydrocarbons. The patentee states that catalysts may or may not be used in his process. Their presence, however, is often useful, since they lower the necessary heat and pressure. Most of the common metals have the power of catalyzing the operation. Copper, nickel, cobalt, iron, etc., or their oxides may be used. In order to present a larger surface for action and to distribute the heat more uniformly, the heating zone may be provided with some inert carrier material, such as diatomaceous earth, saturated with a solution of one of the catalysts. (1,411,255; April 4, 1922.)

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Synthetic Tanning Agents—Soluble tanning agents are produced by condensing at least two molecules of an aromatic hydroxy compound with one molecule of formaldehyde, using an alkaline condensing agent, sulphonating the product with one to two molecules of sulphuric acid and then partly neutralizing. Crude cresol is given as an example of the aromatic hydroxy body; oxides, hydroxides, carbonates or bicarbonates of alkali and alkaline earth metals, ammonia or alkaline salts such as sodium acetate are referred to as condensing agents; while as neutralizing agents, oxides, hydroxides or carbonates of alkali and alkaline earth metals, or ammonium hydroxide or carbonate, may be employed. Instead of formaldehyde, its polymers or compounds giving rise to it may be used; also the condensation may take place at ordinary or increased pressure.

A separate specification covers a modification of the process, in which the sulphonation is followed by condensing the sulphonated resin with an aldehyde and an aromatic compound containing one or more sulphonic acid groups alone or in combination with hydroxyl or halogen groups before neutralizing.

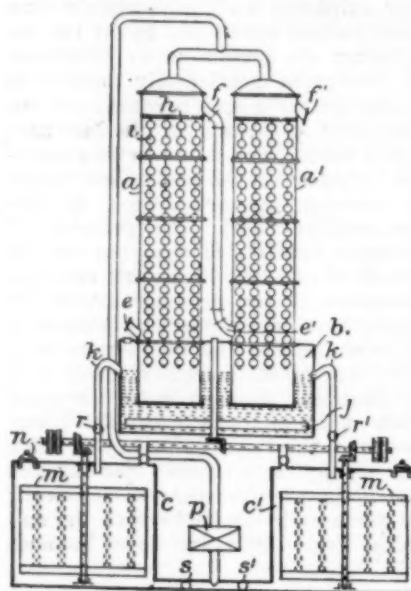
The sulphonated aromatic compound used in the second condensation may comprise the sulphonated resin of the first condensation; and the aldehyde in the second condensation may be formaldehyde or its polymers, acetaldehyde or its polymers, trithioacetaldehyde, aldol or crotonaldehyde. For the partial neutralization, oxides, hydroxides and carbonates of alkali and alkaline earth metals, zinc and magnesium, and ammonium hydroxide and carbonate may be used. Crude cresol is given as the example of the aromatic hydroxy body employed in the first condensation; and crude cresol sulphonic acids and crude α - and β -naphthalene sulphonic acids are given as examples of the sulphonated aromatic body of the second condensation.

Both patents are assigned to McArthur & Co., Ltd., of Liverpool. (Br. Pats. 182,823 and 182,824. R. B. Croad, G. E. Knowles. Aug. 30, 1922.)

Artificial Silk—In the manufacture of artificial silk from solutions of cellulose acetate, nitrocellulose or other ester, ether or derivative of cellulose by a dry-spinning process, the spinning solution is composed of the cellulose ester and a mixture of one or more low boiling point solvents or liquids and a solvent or solvents of high boiling point, and the filaments or threads are drawn out during the spinning, the high boiling point solvent retarding the solidification of the filaments and facilitating the drawing out. Larger jet orifices can be employed for the production of a given denier. The use as high boiling point solvents of tetrachlorethane and like toxic chlorine derivatives is excluded. Suitable high

boiling point solvents are acetone alcohol, acetylacetone, diacetone alcohol and cyclobutanone; such solvents are used in an amount not greater than 50 to 100 per cent of the weight of the cellulose ester. Acetone and methyl acetate are suitable low boiling point solvents, but the latter may be in whole or in part replaced by organic diluents of similar volatility. (Br. Pat. 182,166. H. Dreyfus, London. Aug. 23, 1922.)

Chlorates and Hypochlorites—Relates to the manufacture of chlorates and hypochlorites, more particularly the former, of calcium or magnesium by chlorination of the corresponding hydroxide, and to the preparation of potassium chlorate therefrom. A dilute suspension of calcium or magnesium hydroxide is chlorinated, to which fresh material is added from time to time, until a solution of chlorinated products of 60 to 64 deg. Tw. is obtained. For



example, milk of lime containing about 50 grams $\text{Ca}(\text{OH})_2$ in suspension is prepared in the mixer c , agitated by the stirrers m , and, the valves r , s being closed, is pumped by pump p to the top of the towers a , a' , through which it descends into the vessel b . A distributing plate h , together with ebullite-coated glass balls i , serves to distribute the liquor and expose a very large surface to the action of the chlorine, while at the same time preventing the deposition of solid matter in the towers. Chlorine, of a suitable concentration, passes through the towers, entering at e , e' and leaving at f , f' , as shown. The liquid in the vessel b is agitated by the stirrer j and returns by the siphon k into the mixer c . Thence it is again circulated through the towers. As the chlorination proceeds, fresh lime is periodically introduced into the mixer c through the inlet n . The temperature during chlorination is kept below 70 deg. C. by using diluted chlorine, and, if necessary, by adding water to the liquor in the mixer c . The product of the process, a solution of calcium chlorate and chloride, and possibly hypochlorite, of 60 to 64 deg. Tw., is pumped from the mixer and filtered.

If it is desired to prepare potassium chlorate, potassium chloride, in an excess of 2 per cent over the theoretical amount, is added, and the bulk of the chlorate permitted to crystallize at atmospheric temperature. The mother liquor is diluted, if necessary, until there is present preferably 45 to 50 grams calcium chloride in 100 grams of water, when the liquid may be cooled to -20 deg. C. to separate further quantities of potassium chlorate, without simultaneous separation of ice or of calcium chloride. It is convenient to connect the outlet f' of the apparatus to a similar apparatus in which comparatively fresh milk of lime is being treated. Then when the liquor circulating in the first unit has been completely chlorinated, the valves r , s are closed, and the partly chlorinated lime in the second unit is pumped into the mixer c' for treatment as described above. Preferably, however, the conveyance of liquor is avoided by reversing the order of the units, and conducting the chlorine first to the second unit and then to the first unit, the mixer c' of which contains fresh milk of lime. The chlorine mains are provided with connections which permit this procedure, the connections not being shown in the diagram.

The process may be applied to the production of concentrated hypochlorite solutions. (Br. Pat. 183, 671. M. Wilderman, London. Sept. 20, 1922.)

Urea—In the manufacture of urea by forcing a mixture of ammonia and carbon dioxide into an autoclave, the gases are brought to the necessary pressure by expelling either or both of them from solutions capable of giving them off, by means of heat. By way of example, a concentrated solution of ammonium carbonate or carbamate is forced into a heated column, the gas mixture produced passed through a cooler at about 110 to 150 deg. C., and the condensate run into an autoclave, where it is heated at 130 to 150 deg. C. until the conversion into urea no longer proceeds. The autoclave may be filled and discharged either at intervals or continuously, or the process can be carried out with single charges, when the column is replaced by a pressure-resisting vessel. The unconverted gases are expelled from the urea solution and used, together with fresh gases, to saturate the exhausted liquid from the column for further use. The gaseous ammonia and carbon dioxide may be generated in separate columns—for example, from aqueous ammonia and sodium or ammonium bicarbonate solution respectively—or one of the gases may be forced into the autoclave by means of a compressor. (Br. Pat. 182,331. Badische Anilin und Soda Fabrik, Ludwigshafen-on-Rhine. Aug. 23, 1922.)

Tantalum—The use of tantalum for vessels used in the preparation, distillation or concentration of hydrogen peroxide is covered. (Br. Pat. 184,153; not yet accepted. Chemische Fabrik Weissenstein Ges., Carinthia, Austria. Sept. 27, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields
Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Few Changes Likely Under Elastic Tariff—Blackstrap Error Adjusted

THE TARIFF COMMISSION began active operation of the flexible tariff section of the new act Nov. 9 when it received preliminary reports from its advisory board on fourteen applications for changes which had been filed with it and acted upon five of them. No rates of major interest are involved in the first fourteen preliminary reports, it was announced.

Thus far, seventy-two applications for changes in the new tariff act have been filed with the commission. Of these, twenty seek changes in classifications, which naturally would affect duties. Fifty-two applications seek direct changes in figures in paragraphs of the act, twenty-nine asking decreases and twenty-three asking increases.

CHEMICAL SCHEDULE PROTESTED

The chemical schedule is affected by the second largest number of applications, ranking next to the agricultural schedule, with the sundries third. Five of the applications in the chemical schedule ask that the basis of valuation for assessing duties be transferred from foreign value to American value. This cannot be done under the act unless the Tariff Commission should find and report to the President that a change of 50 per cent upward on the basis of foreign valuation would not equalize the cost of production.

None of the chemical applications was included in the reports of the advisory board first submitted. Definite announcement of the commodities or products affected by the applications has not been made and will not be until the commission decides whether to proceed with an investigation or to dismiss the application.

It is expected that the commission will start an investigation before Dec. 1 of some commodity among the applications in order to get the full machinery of the act under way and to determine the value of the section and its workability.

BLACKSTRAP MUDDLE ADJUSTED

The Treasury Department has issued instructions to customs collectors to collect an additional duty of one-sixth of a cent per gallon on blackstrap molasses testing above 52 per cent total sugars only on the percentage above 52. This order clarifies the situation created by a previous interpretation of the molasses paragraph of the new tariff.

An order along the lines originally

proposed by the department would have created a prohibitive rate on blackstrap testing between 52 and 56 per cent total sugars and would have meant that before such molasses could be imported for use in stock feed it would have to be diluted to bring it below 52 per cent, which would have meant heavier tonnage in this class of imports and consequent heavier expense to the importers. The situation arose through failure of the tariff conferees to make an insertion of three words in the molasses paragraph, which was reframed by special resolution after the tariff bill had been adopted by both houses of Congress.

The Treasury's decision is to interpret the paragraph in accordance with the obvious intent of Congress and to keep the clause in question in harmony with the remainder of the paragraph.

PERPLEXING PROBLEMS

Several perplexing questions with regard to the imposition of the so-called flexible provisions of the new tariff act remain to be decided by the commission. One of the most important is whether the tariff body is authorized to change rates in the case of imports which have no counterpart in American production. The guide laid down by Congress for rate adjustment is the difference in the costs of production at home and abroad, but manifestly in such cases such differences cannot form the basis for a decision.

Potash From Kelp Established as Commercial Enterprise

Not only is there every indication that the kelp-potash plant established by the Bureau of Soils for experimental purposes at Summerland, Calif., will be a permanent commercial enterprise, but plans already are being made for its enlargement. The plant was purchased by the United States Kelp Products Co. after it had been operated for experimental purposes by the Bureau of Soils since 1917. Potash is now being produced at the plant at the rate of 5 tons a day. The principal product, however, is kelp char, which is in much demand as a substitute for bone-black as a bleaching agent.

J. W. Turrentine, who was in charge of the plant for the Department of Agriculture and who has been in charge of its operations since their inception, has returned to Washington to take up anew his research work on potash.

Deterioration Tests on Calcium Arsenate

Quality Not Affected by Age, According to Bureau of Chemistry

No practical possibility exists of change in the chemical composition of calcium arsenate during storage. This conclusion has been reached by the Bureau of Chemistry after exhaustive studies on the keeping qualities of calcium arsenate. The detailed description of the tests and the analyses on which the conclusions are based are being printed and will be available in December.

COMMERCIALLY IMPORTANT

The question of whether or not calcium arsenate deteriorates during storage has been a controversial one. This point is of special importance to the Federal Insecticide and Fungicide Board, not only because the material must be carried over from year to year by farmers and dealers but because the information is necessary in the enforcement of the insecticide act. If material which analyzes improperly is found in the possession of a cotton farmer, it must be known whether or not there is any possibility of this material having been of correct composition when it left the factory and having deteriorated since that time. Under the insecticide act, prosecutions can be made only when the material is shown to be of improper composition when it entered interstate commerce.

TEST CONDITIONS

In making these tests certain lots of material were held in storage at the laboratory of the insecticide board for 6 years and have been analyzed at intervals throughout that period. Other special tests were made of material which had been exposed to extreme conditions during storage. In one series of tests barrels were left standing partly open, totally exposed to the weather, for 11 months. During that time the physical character of the material was altered by rain, but the chemical analysis remained practically the same.

Stocks of calcium arsenate were purchased from eight of the principal manufacturers, selected as representing the principal methods of production. In each case one barrel of the material was left intact in the original package, while the remaining stock of each manufacturer was divided among ten different types of containers, representing all the types used commercially for shipping calcium arsenate.

Midgley Addresses New York A.C.S. Section

Describes Development of Anti-Knock Compound for Gas Engine and Theory of Gaseous Detonation

Before a large and enthusiastic audience in Rumford Hall, on Friday, Nov. 10, Thomas Midgley, Jr., described the now well-known work of the General Motors Research Corporation on "Gaseous Detonation and Its Control." It was substantially the same address which he delivered before the Pittsburgh meeting of the American Chemical Society. The apparatus for the demonstration of the efficacy of anti-knock compound which was used at Pittsburgh was lacking, but the deficiency was more than made up by the delightfully informal and extemporaneous delivery.

IMPROVING FUEL ECONOMY

Mr. Midgley began at the beginning and described the efforts made by different departments to increase the efficiency of internal combustion engines as applied to the automobile. The mechanical engineer would improve the mileage per gallon of fuel by decreasing the gear ratio, but would cut down the potential acceleration of the car and decrease its power on hills. The expert in thermodynamics would increase the compression ratio, but this causes knocking. It looks as if a practical solution of this problem must come from the chemist.

With the aid of his ingenious revolving chart, the speaker described his conception of the mechanism of internal combustion and gaseous detonation. He derived mathematical expressions showing the relation between the pressures on both sides of the explosion face. The equation contains a constant term. If this constant term could be increased or decreased by the use of a catalyst or, in other words, the reaction velocity changed, it would be possible to use a high pressure in the cylinder without causing knocking. "Wouldn't it be a beautiful scientific achievement," he asked, "if, having derived these equations and shown how a catalyst might change the constant term, we should then simply find the proper catalyst? As a matter of fact, that was not how it was done. We found the substance first, and made up the mathematics afterward."

STORY OF DEVELOPMENT

Early in the investigation of motor fuels there was a theory, which, although it proved short lived, was a good theory—not because it was true, but because it led to results. The theory was that fuels which gave gaseous detonation did so because they were not completely volatilized in the explosion chamber. It was believed that as the gas was compressed, the boiling point of the suspended globules of fuel rose, and although the temperature was continually rising at the same time, it never got high enough for the liquid

globules to ignite. Acting on this theory, it was decided to add some coloring matter to the fuel so that it would absorb radiant energy and upset the thermal equilibrium. "We went to the stockroom," said Mr. Midgley, "and asked for an oil-soluble dye." "They did not have any, so they handed out the first thing that came to hand. It happened to be iodine. We made up some brown, some purple and some black gasoline, tried it out, and found that it did not knock. The theory was proved. The same day we got some oil-soluble dye and made up gasoline of the same color with it. It had absolutely no effect on the gaseous detonation. The theory was shot to pieces."

CUT AND TRY RESEARCH

This, however, was the beginning of a series of tests using every element and compound which was available in the laboratory stockroom. Aniline proved to be much better than iodine. Later, tellurium proved to be better than aniline. Up to this time, however, none of the anti-knock compounds tried were commercially practical on account of their high cost and their relative scarcity. Sufficient evidence, however, had been collected by this time to enable the investigators to present the efficacy of various compounds by reference to the periodic table and it was as a result of this line of investigation that lead tetra ethyl was tried out and found to be superior to anything that had been tried before as well as being a commercial possibility."

The talk aroused a great deal of discussion in which Wilder D. Bancroft and J. C. Olsen took part. The ready wit of the speaker made the discussion most interesting and amusing, and on the whole, it was the most human and entertaining meeting that has been held in Rumford Hall for many a day.

Chicago Ceramic Society Plans Annual Meeting

Program Covers Enamel Defects, Smelting Furnaces, Production Planning, Proposed Ceramic Engineering Course

Anticipating a record attendance for its sixth annual meeting, which will be held on Saturday, Dec. 2, at the Morrison Hotel, Chicago, the Chicago section of the American Ceramic Society is planning a meeting with numerous discussions on subjects of live interest to those who will attend.

Briefly, the program now scheduled is to include a discussion on defective enamels by B. T. Sweely, Cribben-Sexton Stove Co. Mr. Sweely spent several months in Washington recently on enamel research work and is well qualified to give a very instructive talk on sheet steel or cast-iron enameling. H. E. Davis, ceramic engineer of Northwestern Terra Cotta Co., will describe a new type of smelting furnace of interest to both enamel and terra cotta manufacturers. A representative from a firm of industrial engineers

which has done work in the ceramic industries on glass, enamel, pottery and brick plants will speak on some phase of production. A representative of the Chicago Board of Education will tell of the efforts being made to establish a course in ceramic engineering in the new Crane Junior College just completed. The establishment of such a course would be of great value to the ceramic industries in the vicinity of Chicago, and manufacturers of that section ought to be vitally interested in the discussion that will take place at this meeting.

The event will open with a luncheon at the Morrison Hotel at 12:30 Saturday, Dec. 2, the program following immediately after luncheon. All persons interested in ceramics are cordially invited to attend this meeting.

New Italian Ambassador An Accomplished Engineer

Caetani Studied and Practiced in America—Distinguished Service in War Won Him Decorations

The appointment of Gelasio Caetani, a member of the Chamber of Deputies of Italy, as Italian Ambassador at Washington has been received with interest by American engineers, among whom Prince Caetani has many friends.

He was graduated from the School of Mines of Columbia University in 1903 and went West, working as a miner, trapper, timberman and mill-hand at Stratton's Independence mine in Colorado, at the Treadwell in Alaska, and at the Bunker Hill in Idaho. He carried through some important projects for the Bunker Hill & Sullivan Co. and later opened offices in San Francisco as a consultant. As a member of the firm of Burch, Caetani & Hershey, Mr. Caetani was engaged in important jobs, mostly in Montana.

BRILLIANT WAR RECORD

At the outbreak of the war Don Gelasio returned to Italy, and was made a Captain in the First Regiment, Royal Engineers. Before the end of the war he was a Colonel. The feat which won world-wide fame as an engineering exploit was the blowing up of the top of the Col di Lana, which destroyed an Austrian fort and opened the way for the Italian army through the Cordevole Pass in the upper Trentino.

After the war he combined business with politics and was elected to the present Chamber as a Nationalist. According to letters received by his American friends, the new Ambassador was one of the first of the Roman nobles to embrace the Fascismo—in fact, he is said to have enrolled himself among the original ninety Fascisti organized as a Roman cohort in 1920.

The choice of Prince Caetani as Ambassador is considered an admirable one, because of his familiarity with American affairs. The date of his departure for the United States has not been fixed.

Coal Commission Gets Down to Business

Dr. Smith Resigns as Director of Geological Survey to Serve on President's Committee

The fact-finding machinery being set up by the President's coal commission is now taking definite form. While the commissioners expect to get much of their information from the broad conclusions from outstanding men engaged in coal production, distribution, wholesaling and retailing, a vast amount of data must be collected by a technical staff. That portion of the work which deals with costs of production will be under the immediate direction of David L. Wing, whose title is to be expert investigator. As the work progresses, Mr. Wing will gather other statistical facts.

C. E. Leshar, editor of *Coal Age*, has been drafted to direct the engineering investigations which the commission will conduct. Coal specialists from various bureaus will be transferred to the commission.

ASSOCIATIONS WILL CO-OPERATE

Assurances of co-operation have been given by each national association connected with the coal business. A statistical program is being worked out which it is believed will cause very little dissension. It is being arranged so that those engaged in the business can furnish the information in the way it is carried on their books. President Stephens of the Retail Coal Merchants' Association has conferred at length with members of the commission, and so has a committee representing the public utilities. More formal conferences are in contemplation. The one with the retailers is to be held the latter part of November. There is every evidence that the commission will have the whole-hearted co-operation of the whole coal business.

Where statistical and other information is furnished by one branch of the industry, arrangements are being made whereby the other branches concerned and the commission itself can check the figures as they are being compiled. In this way it is hoped to compile statistical data the correctness of which will be admitted by each branch of the industry.

SMITH RESIGNS FROM SURVEY

Since the government's law officers decided that Dr. George Otis Smith may not lead a double official life, it became necessary for him to resign his position as director of the United States Geological Survey. After having discussed the matter personally with the President, Dr. Smith presented a formal resignation in which he, among other things, said: "Some plans I have had in mind for the betterment of the Geological Survey's contributions to the public are unfinished, even after my 15½ years as director. I therefore regret this break in my work, yet while I hope I may have an opportunity for further service with the Geological Sur-

vey, I appreciate so keenly the importance to the nation of the task you have intrusted to the coal commission that I am willing to make any sacrifice needed to enable me to devote all my energies to that work for the next 11 months."

In his reply and in a statement issued at the White House, the President explained that Dr. Smith's resignation is of a temporary character and that he will be reappointed as director of the Survey when his duties with the coal commission will have been concluded.

PERSONNEL GENERALLY APPROVED

The same provision of law bars Judge Alschuler from serving in two official positions. The President will ask Congress to make an exception in this case, but until such a law is passed Judge Alschuler will not qualify as a member of the commission. He will work with the commission, however, in an informal capacity.

The Geological Survey comes in for praiseworthy mention in the recent editorial in the *Philadelphia Public Ledger*. In discussing the coal commission, the editorial says: "The appointment of George Otis Smith was an act for which Mr. Harding cannot be commended too highly. The Geological Survey is purely scientific, non-political, magnificently efficient and brilliantly administered."

The coal commission has been endeavoring since its organization to arrange for the appearance before it of both Secretary Hoover and Secretary Davis. Other duties of these Secretaries, however, have made this impossible.

American Foundrymen's Directors Organize—Accept French Invitation

The board of directors of the American Foundrymen's Association met in Chicago Oct. 3 and completed its organization by electing C. E. Hoyt secretary-treasurer, R. E. Kennedy assistant secretary, R. A. Bull, S. T. Johnston, L. W. Olson and Fred Erb, together with the president, vice-president and secretary, will constitute the executive committee of the board of directors for the coming year. S. Griswold Flagg, 3d, of Stanley G. Flagg & Co., Philadelphia, Pa., was elected a director to fill the vacancy caused by the death of J. P. Pero.

The directors provided for a permanent board of awards, consisting of the seven last living past presidents of the American Foundrymen's Association, Inc., with the junior past president as chairman of the board.

An invitation was received from the Association Technique de Fonderie, of France, inviting the A.F.A. to join with the foundrymen's associations of France, England and Belgium in an international convention and exhibit in Paris in September, 1923. The invitation was accepted and referred to a committee to be appointed by the president, who will represent the A.F.A. and determine to what extent the association will take active part in the proposed international convention.

Discusses Human Factor in Engineering

Personnel Association Urges Active Support of Technical Colleges by Industries

Co-operation with the engineering colleges, the public schools and industries of the nation in enlarged educational effort was urged by committees of the National Personnel Association in reports presented at the closing sessions of the first annual convention of the association in Pittsburgh last week.

"The present state of engineering education is one of active flux," said the report of the committee on relations with engineering colleges, consisting of W. E. Wickenden, American Telephone & Telegraph Co., New York; F. L. Bishop, dean of engineering, University of Pittsburgh; and G. H. Pfeif, secretary, educational committee, General Electric Co., Schenectady, N. Y.

"Educators and officers of industry are agreed that the demands of civilization on the engineer are becoming broader and call for a more fundamental and less specialized form of education. Engineers have achieved brilliant success in creating the machines and structures which make modern industry possible. They are now being called upon to give equal concern to the agencies of society which utilize this material equipment."

HUMAN ELEMENT IN ENGINEERING

The committee stressed the importance of the "human factor" in engineering, saying:

"As engineers constitute an increasingly influential group in modern industry and government, all member companies are concerned that the schools shall ground them in sound principles and equip them with sound methods in their relations to social and economic questions. There is a need that engineers shall attack these questions with the same unprejudiced, fact-finding, analytical methods that they have used with such marked success on material problems. As a balance to these dispassionate, scientific methods there is an equal need among engineers for sympathetic insight into human motives and aspirations and an understanding of the principles which underlie governmental, business and industrial organization."

INDUSTRY OWES SUPPORT

"The engineering colleges have a strong claim on the assistance of the industries in return for services rendered," continued the report. "The schools have made inestimable contributions to scientific knowledge from which the industries have profited without cost. Education has increased earning power and so has made possible the markets on which many industries depend for existence. The colleges have expended on each engineering graduate from \$800 to \$2,000 above all fees received. The industries profit by this and would have to provide costly substitutes for it if it were not available."

Will Pass on Merit of A.C.S. Papers Before Meeting

Industrial Division Hopes to Improve Quality of Material Submitted

In order that more time can be given to the presentation and discussion of papers delivered before the industrial division of the American Chemical Society, it has been decided to ask all who plan to give papers before this division to submit completed manuscripts not later than March 1 to the secretary of the division. The manuscripts will then be sent to reviewers. Upon favorable recommendation of the reviewers and the officers of the division, the papers will be included in the final program of the division.

It has been felt for some time that something must be done to raise the standard of some of the papers which have been given before the division. In some cases old material has been re-described under a new heading, which often was misleading. No doubt the new method will reduce the number of papers to be presented at any one meeting, but it is felt that a few genuinely good papers followed by a sufficient time for discussion will be what most chemists desire. At the Pittsburgh meeting there were so many papers on the program that a time limit of 7 minutes was allotted, with 3 minutes for discussion. This time proved to be so short that a speaker could not present the paper in the best manner possible, and the period for discussion was so short that there was practically no attempt on the part of members to discuss the subject.

Since the spring meeting occurs at New Haven April 5 to 7 inclusive, it is necessary for members of the American Chemical Society who are planning to present papers before the industrial division to send their papers on or before March 1 to Erle M. Billings, Kodak Park, Rochester, N. Y., secretary of the division.

Belgians and Germans Dominate European Cement Market

Belgian and German cement makers have succeeded through the policy of price cutting in almost completely arresting exportation of French cement in the last 3 months, according to reports received by the Iron and Steel Division of the Department of Commerce. The factories at Boulogne-sur-Mer, the largest cement-manufacturing center in France, are capable of producing 600,000 tons annually, or about three-fifths of the total French production. Conditions in this region are typical of the situation throughout the entire industry. It is estimated that the cement industry during the last week of July was working at about 80 per cent of normal, whereas the first weeks of the month it was only working at 70 per cent.

French exporters are still shipping a small quantity of cement which they are content to sell at the cost of production.

Efforts Needed to Improve Salary Standards of Government Chemists

A determined effort is being made to convince the Navy Wage Board that chemists in the naval service should be better paid and should be differently classified. The Wage Board is now in session considering revisions in the wage scale. Under the law, wages of the employees in the naval establishments must conform with those paid by comparable private establishments. In the case of chemists, it is particularly difficult to find chemists in private industry doing work of the same character. For that reason it is particularly hard to bring before the board convincing evidence as to pay in private industry. The situation of chemists in the navy is so bad that frequently their title is changed to "master mechanic" or "powder expert" so as to make it possible to pay them enough money to retain them in the service.

Revised Gasoline Specifications Approved

The Interdepartmental Petroleum Specifications Committee announces that its latest revision of the federal specifications for petroleum products was approved by the Federal Specifications Board on Oct. 31.

The one outstanding change in the specifications is in motor gasoline, the initial boiling point being lowered to 55 deg. C. and the 90 per cent point raised to 200 deg. When the specification for motor gasoline was last amended in 1919 it was hoped that the specification would be satisfactory for at least 2 years. It has actually been in effect 3 years and improvements in the refinery practice in this period have indicated that the specification could be modified to advantage. This has accordingly been done. The specification for domestic aviation gasoline has been modified to permit the use of cracked gasoline in cases where the material is to be used within 3 months. A corrosion test has been substituted for the doctor test in the specification for mineral spirits. Grade 2 of Liberty aero and motorcycle oil has been dropped, as this oil is not being purchased at the present time. A few minor changes have been made in some of the other specifications.

The specifications in force previous to Oct. 31 are given in Technical Paper 305 of the Bureau of Mines, and the methods adopted by the committee for testing petroleum products in Technical Paper 298. It is planned to publish the revised specifications, together with the testing methods, as Technical Paper 323, which will be issued by the Bureau of Mines as soon as possible.

The Interdepartmental Committee held an open meeting on July 3, and comments and criticisms on the specifications and testing methods were considered, and such changes as were adopted are incorporated in the revised set of specifications.

Patent Office Still Swamped

Flood of Applications and Heavy Turn-over in Personnel Pile Up Work

Despite enactment by Congress last spring of a bill readjusting salaries upward in the Patent Office and authorizing twenty-nine additional examiners and twenty-two clerks for the personnel, the work of the office is no more advanced in overtaking the number of pending applications than it was a year ago. This is attributed to a steady increase in applications for patents and extensions and to increase in applications for the registration of trademarks.

With the revival of industry, the Patent Office also is having difficulty in holding experienced technical men as examiners against the inducements of private employment. While 362 examiners are authorized, approximately a dozen vacancies exist because of inability of the Civil Service Commission to supply qualified men at the salaries offered.

It was stated at the Commissioner's office that within 49 working days twenty-two examiners submitted resignations. It is figured that it requires 6 months for a new employee to become accustomed to an examiner's work, so that resignations are especially serious when they affect this staff. Also, if two resignations come in a single division, two divisions are disturbed, as one new man is put in and an experienced examiner is transferred from some other division to fill the second place. In one division the examining staff now consists of two who have been with the Patent Office 3 years, two who have been there 2 years and three who have been there less than a year.

In several weeks this year the Patent Office has cleared more patents than it has received applications. The flood of applications which set in during and after the war, however, has made it difficult to speed the work as had been hoped for. Up until Nov. 1, 32,582 first patents had been issued for the calendar year, compared with 37,885 during the 12 months of 1921, which shows a higher rate of issuance this year. On Jan. 3, however, there were 60,244 cases up for action in the office and on Oct. 31 these had increased to 70,313. The greatest activity among applicants has been along chemical and electrical lines.

Large Industrial Alcohol Distillery Incorporated

The Canadian Industrial Alcohol Co., Ltd., was incorporated under Dominion Government charter on Oct. 27. The capital of the company is \$10,000,000, and the main office is at Montreal. The provisional directors are: James Shaughnessy, a son of Baron Shaughnessy, former president of the Canadian Pacific Ry.; A. R. Holden, H. J. Hague and Chilton G. Howard. No announcement has been made as to the location of the distilleries or from what the product is to be made.

Fertilizer Association Boosts Soil Improvement

States Will Co-operate With Committee—Prizes for Best Fertility Programs

Of the twenty-six states embraced within the activities of the soil improvement committee of the National Fertilizer Association, twenty-four have completed arrangements to co-operate with the organization's soil fertility program plans and a number of county agents have registered for the work. One other state is expected to join and one has declined.

In order to interest county agents in surveying their fields to formulate a definite soil fertility program, the soil improvement committee has offered to defray the expenses of eight agents who can show the best organized work along soil-fertility lines in their respective counties to attend the 1923 meeting of the American Society of Agronomy. The agents are being reached through the extension work of the state experiment stations and register both with the station and with the committee.

The territory to be covered has been divided into four sections, each of which will have two trip-winners. Agents first will submit their programs to the state station, which will select the three best. The best three from each state will be judged by a committee comprising Director S. B. Haskell, Massachusetts Agricultural Experiment Station; Dr. A. G. McCall, in charge of soil investigations, Maryland Agricultural Experiment Station; Dr. Firman E. Bear, professor of agricultural chemistry and soils, Ohio College of Agriculture, and Prof. M. F. Miller, professor of soils, Missouri College of Agriculture.

The object of the plan is to promote a more intelligent use of fertilizer by studying and analyzing the results of soil experiments and interpreting these results for the fertilizer industry and the farmers. The program will be judged according to their application to the needs of the section affected and naturally will not be of uniform character.

Surplus Smokeless Powder Transferred to Department of Agriculture

The director of sales announces the transfer to the Department of Agriculture by the Ordnance Department of 46,995,474 lb. of smokeless powder located at the following points: Woodbury, 6,520,100 lb.; Old Hickory, 25,057,239 lb.; Curtis Bay, 184,897 lb.; Amatol, 428,250 lb.; Seven Pines, 9,639,309 lb.; Tullytown, 4,636,552 lb.; Charleston, 529,126 lb.

This transfer, with 5,000,000 lb. previously transferred to the Bureau of Mines, Department of the Interior, disposes of the entire stock of smokeless powder reported surplus to the director of sales, with the exception of 12,312 lb. which still remains surplus and available for sale.

Tendency Toward Federation in Engineering Growing

L. W. Wallace, executive secretary of the Federated American Engineering Societies, has completed a coast-to-coast tour, during which he set in motion plans for Federation expansion, stressing the great influence exercised by the Federation since its organization about two years ago under the presidency of Herbert Hoover and evidencing this by the report of its committee on the elimination of waste in industry, as well as by the report of the committee on work periods in continuous industry and by other substantial achievements. Mr. Wallace was attentively heard by large engineering gatherings in many cities. Everywhere, he reports, engineers are recognizing the enormous potentialities for technical and public service which reside in the Federation as the instrument of expression and action of the engineering profession in America.

NEW YORK INDUSTRIAL CONFERENCE

"Elimination of Waste in Industry" will be the theme for discussion Wednesday, Nov. 22, at the sixth annual New York State Industrial Conference to be held at the Hotel Lafayette, Buffalo, for three days beginning Nov. 21. Mr. Wallace will deliver the opening address at the session, his topic being "Wasteful Industrial Habits." H. F. Simmons of the General Electrical Co., Schenectady, will speak on "How to Prevent Waste of Materials." Other speakers at the conference will include Gov. Nathan L. Miller.

Hoover Reiterates Attitude Toward Metric System

While believing that the metric system can be applied to good purposes in the scientific field, Commerce Secretary Hoover has in no way altered the opinion he has expressed on several occasions since assuming his portfolio. It is his opinion that there is nothing to justify the general application of the metric system at this stage of the country's development. When productivity is important, it would be unwise "to warp the brains of the country's mechanics" in their efforts to acquire the metric system, Mr. Hoover says. He thinks much of the propaganda for the metric system comes from a single indefatigable enthusiast.

First Iron Furnace in Central Pennsylvania 130 Years Old

The first iron-smelting furnace ever operated in central Pennsylvania, located on the outskirts of State College, was marked with a tablet under appropriate dedication ceremonies on Oct. 30. The furnace was constructed 130 years ago, as set forth on the bronze tablet, given by the State Historical Commission and the department of history of the Pennsylvania State College. Former President E. E. Sparks of the institution presided at the dedication ceremony, in which the students and faculty of the college participated.

Patent Board Formulates Policies

Regulations for Handling Patents Evolved by Government Employees

With the idea of drafting regulations establishing a policy to be followed by the federal government in the handling of inventions and patents evolved by government employees and other inventions and patents acquired by the government, regular meetings are being held by the Interdepartmental Patents Board. This board recently was set up by an executive order issued by the President. Any policy proposed by this board is to be presented, through the Secretary of the Interior, to the President for his approval. The regulations also will suggest a plan whereby information concerning patents, applications for patents, licenses and other rights under patents, owned by the government, may be disseminated to all the bureaus concerned.

At the present time the activities of the board are being concentrated on the collection of data which will furnish the basis on which any policy proposed will be founded. In the past little effort has been made to co-ordinate patent policies of the different federal bureaus. As a result there has been confusion and duplication. This, the board believes, can be obviated and plans made which will permit of a more intelligent and effective handling of all departmental patent matters.

Andrew Stewart, of the Bureau of Mines, is chairman of the Interdepartmental Board. Colonel Joseph I. McMullen, of the General Staff, is its secretary. The other members are: F. G. Cottrell, Fixed Nitrogen Research Laboratory; S. W. Stratton, director, Bureau of Standards, and Harry E. Knight, Department of Justice.

Mexico Encourages Development of Naval Stores Resources

American naval stores operators, according to advices reaching Washington, are paying increased attention to the possibilities of development of the industry in Mexico. Scarcity of turpentine timber and rising costs in this country, coupled with special inducements from Mexico, are encouraging experienced American operators to consider the establishment of enterprises there. In fact, American interests already are operating on a small scale in Mexico.

The acreage of turpentine timber in that republic is known to be large. It can be obtained at very low prices. Labor is cheap and some of the Mexican states are prepared to authorize tax exemptions to encourage the industry. On the other hand, there are the drawbacks of unsettled political conditions and the difficulties of transportation. The situation, however, is regarded as being of moment to the domestic industry, the prosperity of which is dependent to a considerable extent on the retention of its foreign markets.

Standardization Efforts of Department of Commerce

While the Simplification Division of the Department of Commerce is pressing lumber, hardware and containers as immediate objectives of a major nature, it is co-operating with trade organizations representing more restricted scope at the same time and plans are being laid for new fields of endeavor in 1923.

William A. Durgin, chief of the Simplification Division, was scheduled to address the National Paint, Oil and Varnish Association on Nov. 14 at its convention in Atlantic City to further the work of standardization which has been started by that organization. The association has under way a survey of colors and of containers which is expected to lead to more economical practices.

The American Salt Producers Association also will be addressed by Mr. Durgin while he is in Chicago. This association is looking toward simplification of containers. Mr. Durgin will also speak before the American Petroleum Institute in St. Louis on Dec. 6 on the subject of the same standards for oil well supplies and materials in the different fields of the country.

STANDARDIZATION OF CONTAINERS

One of the largest subjects taken up by the division is that of containers—metal, wood and pasteboard. This affects such a large number of producers and consumers that the division has assigned a special attaché to this subject. A general conference on containers will be held in Washington under the auspices of the Department of Commerce in January, and probably will occupy a week's time.

Washington Chemists Elect Officers

At the November meeting of the Chemical Society of Washington, W. M. Clark of the Hygienic Laboratory was elected president for the coming year; J. B. Reed and H. W. Houghton were re-elected secretary and treasurer, and councilors of the American Chemical Society were elected as follows: W. W. Skinner, R. B. Sosman, R. C. Wells, W. D. Collins and F. C. Cook.

The Washington chemists will join the Baltimore section on Friday, Nov. 24, for a visit to the new refinery of the American Sugar Refinery Co. in Baltimore. A special joint dinner will be held that evening at the Engineers Club, followed by a brief technical session.

Steel Treaters Organize Classes in Heat-Treating

Under the direction of the Indianapolis Chapter, American Society of Steel Treating, arrangements are being perfected for the establishment of a local class to meet at the Arsenal Technical School for studies in heat-treating of steel. The course has been designed for employees of local manufacturers,

who are co-operating in the plan, and will be closely associated with the Purdue University Extension Department. Twenty persons have signified their intentions of entering the class, and it is expected that this number will be increased to fifty.

Civil Service Openings

The United States Civil Service Commission announces open competitive examinations for junior chemist on Dec. 6, 1922. Vacancies in the departmental service, Washington, D. C., at \$1,200 to \$1,800 a year will be filled from this examination.

Positions in the federal classified service throughout the country and the departmental service in Washington for laboratorians—chemical, physical and engineering—are also open and will be filled from applicants who take examinations on Dec. 6 and 7. Salaries range from \$1,200 to \$1,500 a year.

Both the above carry the additional \$20 a month bonus for satisfactory service.

Agricultural Chemists Meet in Washington

Standardization of Analytical Methods to Be Attempted—Notable Speakers

Federal and state chemists engaged in agricultural and food chemical work throughout the United States will attend the thirty-eighth annual convention of the Association of Official Agricultural Chemists to be held in Washington, D. C., at the Raleigh Hotel, Nov. 15 to 17. Particular consideration will be given at this convention to agricultural chemistry with regard to the control laws affecting food and drugs, stock feed, commercial fertilizers, and insecticides and fungicides.

One of the chief objects which the association will attempt to accomplish at this convention will be a standardization of the methods used by the various analytical chemists engaged in the work at different stations, so that the findings of one station may be comparable to those of another station. The methods devised and recommended by the association have become quite generally used, but it is hoped that there will be a still further co-ordination of effort effected.

PROMINENT SPEAKERS

Approximately seventy-five subjects will be discussed in the 3 days' meeting by as many different chemists covering a wide range of work. On Nov. 16 the association will be addressed by Secretary of Agriculture Wallace, Dr. H. W. Wiley, honorary president of the association and former chief of the Bureau of Chemistry, and Dr. F. P. Veitch of the Bureau of Chemistry, United States Department of Agriculture, president of the association.

Senator E. F. Ladd of North Dakota, who is a chemist and was at one time head of the chemistry division of that state and president of this association, will also address the convention.

To Close Gap in Byproduct Coke Statistics

The U. S. Geological Survey has recently been getting a monthly report of byproduct coke output corresponding to the reports received during the war. However, figures have not been available for 1919 and 1920 and the Survey is now planning to get these data so that there will be a continuity of record from 1917 on.

The Survey is urging co-operation of the industry in this matter. It is recognized that the data are of very great industrial significance not only in the coke industry itself but also to metallurgical industries and fuel users generally. An early summary of the data is promised if prompt reply is received by the Survey.

Personal

BURTON T. BUSH and M. J. SEELEY, of Antoine Chiris Co., New York, sailed for Europe Oct. 24 on the Aquitania. They expect to return early in December.

GASTON DUBOIS, president of Monsanto Chemical Works of St. Louis, sailed Saturday, Nov. 4, on the Mauretania for a business trip to England, France and Germany. He expects to return late in December.

HUGH M. HENTON, consulting engineer, of Cleveland, Ohio, has arrived at Pullman, Wash., to succeed Prof. Chester G. Warfel, who died last summer, as assistant professor of mining and metallurgy in Washington State College. Professor Henton has been connected with the Case School of Applied Science and with the South Dakota School of Mines, of which he is a graduate. At one time he was director of research for the Aluminum Castings Co. of Cleveland.

SAMUEL L. HOYT, formerly metallurgical engineer in the experimental engineering laboratory at Nela Park, Cleveland, is now in the research laboratory of the General Electric Co. at Schenectady.

Dr. GEORGE OTIS SMITH has resigned as director of the U. S. Geological Survey in order to qualify logically as a member of the President's Coal Commission. The responsibility for the conduct of the Survey during the next 11 months will be in the hands of Philip S. Smith, who has been the Survey's administrative geologist.

Obituary

WILLIAM D. HOWE, vice-president of the Clark Chemical Co., of Denver, Colo., died recently, at the age of 69.

CHARLES J. TAGLIABUE, president and founder of the C. J. Tagliabue Manufacturing Co., of Brooklyn, died recently.

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities
Prevailing Prices and Market Letters From Principal Industrial Centers

Distribution

This General Problem Is Being Intensively Studied Now Because of the Enormous Economic Waste Bound Up With It—What Will Be the Outcome?

WE HAVE reached an efficiency in production which has never been equaled before. It is possible for us to flood the country with almost any commodity within a short time. Production is almost too efficient. Small wonder that, in company with Herbert Hoover, business men have been turning their attention to distribution and its obviously wasteful methods.

A short time ago a manufacturer asked us to estimate the per cent which his effective sales effort represented of his total sales activity. We passed. "Less than 1 per cent," he announced. "Yet my salesmen are successful according to ordinary standards and well paid." This estimate may be lower than the average, but it is qualitatively representative.

Here is a real problem! What are we going to do about it? Is it reasonable to expect better results from the better use of the present tools? Let us suppose that we redistribute advertising on a new basis, plan selling effort more effectively, retain only the most efficient salesmen, revise credit terms. Can we raise the ratio of effective selling up to a reasonable figure of efficiency?

THE DANGER OF GENERALIZATION

Any such question must be individual and specific. Very few generalizations are possible when it comes to problems of business procedure. Take, for example, the cry which has gained considerable force recently, "Away with the middleman! Let us have direct to consumer sales! It will save millions and reduce high prices!" It must be confessed that it has a logical sound. During a recent railroad strike many freight cars destined for New York City had to be unloaded in the suburbs. We recall a fleet of five or six beautiful Packard trucks which bore an inscription something like this:

Coogan & Mooney,
Commission Merchants,
Onions Exclusively
165 X St., New York City.

It was rather an overwhelming idea. Six beautiful trucks bespeaking great prosperity, all on commission selling of onions. The prosperity of such a company argued ill, it seemed to us, for an efficient distribution machinery in modern society. Were those trucks

and the profits behind them a necessary tax on society? We felt not. So we grant, then, that it looks as though there was too much middleman occasionally.

THE OTHER SIDE OF THE PICTURE

A young and enthusiastic executive once said: "Away with dealers! We will market our own products!" This he proceeded to do. A live sales manager and a flock of promising salesmen were procured and a great future was predicted. At the end of the year there were no increased profits. In fact it looked very much like a loss. "Why?" groaned the young executive. The dealers marketed a hundred products. They distributed their selling overhead over all of them. Consequently even assuming that their established clientele was of no advantage whatever, they could distribute more cheaply than the producer with his fifteen products. The moral is: Do not fall into an easy way of talking about business problems by means of formulas. The middleman is not a menace to be eliminated. In some industries he is undesirable. He is often a very salutary influence. The problem of distribution will not be solved by eliminating him.

SOME METHODS OF TACKLING THIS PROBLEM

Let us consider some possible ways and means of effecting distribution economy. First, there are the conventional methods of increasing efficiency in the sales department which have already been referred to.

Study advertising mediums and redistribute advertising effort.

Co-ordinate work more effectively with advertising.

Estimate individual efficiency of salesmen or dealers.

Consider possible variations in terms of credit.

Study changes in product or packaging to attract consumers.

And many other similar studies which have to do with the structure and policy of the department.

A second and exceedingly important method, as yet little tried, has to do with a study of economic conditions in a given district or trade. At the present time a sales manager hears from

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week	158.70
Last week	157.01
November, 1921	146.82
November, 1920	240
April, 1918 (high)	286
April, 1921 (low)	140

The advance in the index number is due to strengthening in the price of cottonseed oil primarily. It indicates, however, a continued strong healthy market. Reference to the market letters confirms this and reveals a weaker market in very few commodities.

his salesmen that St. Louis is dead or that the metal-working business is poor. It is becoming increasingly possible for the sales manager to advise the salesmen from his office that St. Louis will be dead for several months or that the metal-working trade will be poor in a short time. This is not by guesswork or by tips, but by business statistics.

It will remind you a little of the White Queen in "Alice Through the Looking-Glass," who screamed terrifically and nearly fainted because she was going to scratch her finger. When she did prick it on a pin, she said: "See, I told you so!" So with statistics! We shall be able to predict depressions, local and national, and this will help to decrease the inflation and make the reaction less severe.

CHANGES ARE INEVITABLE

Thus the sales manager will have to be an economist as well if he is to put his department upon the highest plane of efficiency. Distribution is and will be the major problem of industry during the next decade. The prizes for the courageous will be exceedingly great. Important and revolutionary changes are certain. This does not mean that they will be consistent—they may be fundamental in industries or in individual companies and yet the composite picture reveal but slightly the fundamental changes. Advertising is bound to be vastly different, with more science, more statistics and less general chatter about reaching markets and benefits accruing. Sales will probably become in general a producer-to-consumer proposition, but the middleman will still continue serviceable, often invaluable. Sales will have to be more intelligently, more deftly, guided. It is a quantitative era in distribution, and many pet nostrums will die of old age and their propagandists will look for clerical work.

The New York Market

NEW YORK, Nov. 13, 1922.

The general tone of the chemical market remained quite steady during the past week. Actual transactions were not as numerous as in previous weeks. However, spot material remained exceedingly firm, with buyers unable frequently to purchase desired quantities. Formaldehyde continued its upward trend and consumers were forced to pay top prices. Competitive selling has practically disappeared from the market and first hands were in control of any available supplies. The feature of the week's trading was again centered around commercial white arsenic. Manufacturers have announced a new advance and importers were quoting considerably higher for shipment material. All tin commodities have been advanced, due to the higher prices for the metal. Bichromates held quite steady. Prussiate of soda showed signs of weakness and prices were much lower in several important trading quarters. The alkali market recorded very little change and prices were firmly maintained among leading producers. Acetate of lead was again advanced on account of the higher prices for lead.

GENERAL AND SPECIAL CHEMICALS

Acetate of Lead—Makers have advanced all varieties 1c. per lb. The general range is as follows: Brown broken, 10½c. per lb.; white crystals, 12c. per lb. in casks; white granular, 12½c., and white powdered, 12½c. per pound.

Arsenic Oxide—Spot goods have been in limited supply and small lots sold as high as 11½c. per lb., with the range around 11½@11½c. per lb. Shipments were strongly maintained around 11c. per lb. c.i.f. New York.

Bleaching Powder—The spot market presented a quiet appearance, but large consumers showed an interest in contract deliveries. Several sales were recorded for contract over next year at 2c. per lb. f.o.b. works in large drums. Spot quotations are held at 2c.

Caustic Potash—Imported material showed some firmness and figures were fractionally higher around 6½c. per lb. for spot goods.

Caustic Soda—No important change has been noted in the export market and producers are holding prices at \$3.60 per 100 lb. f.a.s. The domestic demand is routine at \$3.75@4 per 100 lb., ex-store.

Cobalt Oxide—Spot material was somewhat higher and demand seems to have materially improved. Black oxide is held around \$2.10 per lb., with the gray ranging around \$2.35@2.40.

Copperas—The spot market is in an exceedingly tight position. Material at the works is moving at a very slow rate and consuming demand far exceeds the spot supply. Several sales were recorded at \$28@30 per ton for spot goods. Shipment material in bulk was quoted at \$21 per ton.

Formaldehyde—The market is reported firmer in all producing quarters

Some Production Statistics for Sulphuric, Nitric and Mixed Acids

Reports made by the Department of Commerce show a considerable decrease in the activities of the establishments engaged chiefly in the manufacture of sulphuric acid, nitric acid and mixed acid during the year 1921 as compared with 1919. The total value of products reported for 1921 amounted to \$20,529,000, and for 1919 to \$31,470,000, a decrease of 34.8 per cent. Of the thirty-five establishments reported in 1921, five were located in New Jersey; five in

has been accompanied by decreases in the number of persons employed, in the total amount paid during the year for salaries and wages and in the cost of materials used.

The statistics for 1921 and 1919 are summarized in Table I.

Detailed statistics of production for 1921 and 1919 are given in Table II. These acids are also produced to a very considerable extent by establishments primarily engaged in the manufacture of other products: Sulphuric acid by manufacturers of fertilizers, explosives, chemicals in general, and petroleum refineries; and nitric and mixed acids by

TABLE I—COMPARATIVE VALUE OF PRODUCTS AND OTHER RELATED DATA IN 1919 AND 1921 FOR SULPHURIC, NITRIC AND MIXED ACIDS

	1921	1919	Per Cent of Decrease*
Number of establishments.....	35	39	46.4
Persons engaged.....	3,139	5,860	46.4
Salaried employees.....	450	899	49.9
Wage earners (average number).....	2,684	4,961	45.9
Salaries and wages.....	\$5,243,000	\$10,096,000	48.1
Salaries.....	1,317,000	2,179,500	39.6
Wages.....	3,926,000	7,916,500	50.4
Paid for contract work.....	.....	48,000	.....
Cost of materials.....	9,714,000	15,857,000	38.7
Value of products.....	20,529,000	31,470,000	34.8
Value added by manufacture†.....	10,815,000	15,613,000	30.7

* Percentage omitted where base is less than 100.
† Value of products less cost of materials.

TABLE II—PRODUCTION OF SULPHURIC, NITRIC AND MIXED ACIDS IN 1921 AND 1919

	1921	1919	Per Cent of Total Production, All Industries	Per Cent of Decrease
Total value of products.....	\$20,528,900	\$31,470,500	.....	34.8
Sulphuric acid (basis 50° B _e .)—				
Tons (3,000 lb.).....	1,457,500	1,685,300	50.6	13.5
Value.....	\$15,332,700	\$18,113,000	.....	15.3
Average value, ton.....	\$10.50	\$10.75	.....	.....
Nitric acid—				
Tons (2,000 lb.).....	2,110	3,150	16.2	33.0
Value.....	\$363,700	\$536,700	.....	32.2
Average value, ton.....	\$172	\$170	.....	.....
Mixed acid—				
Tons (2,000 lb.).....	16,400	28,200	60.7	41.8
Value.....	\$1,316,000	\$2,671,500	.....	50.7
Average value, ton.....	\$30	\$95	.....	.....
All other products.....	\$3,516,500	\$10,149,300	.....	65.4

Pennsylvania; four in Ohio; three each in California and New York; two each in Maryland and Virginia, and one each in Alabama, Arkansas, Colorado, Connecticut, Illinois, Kansas, Massachusetts, South Carolina, Tennessee, Texas and Utah. New Jersey, the leading state in the industry in 1921, produced 27 per cent of the total value of products in that year.

The decrease in the value of products

and 14c. per lb. seemed to be the general asking figure.

Prussiate of Soda—There has been a pronounced selling pressure in this product and prices were much lower on spot. Sales were reported as low as 21½c. per lb., although the general figure was around 22c. per lb.

VEGETABLE OILS

Linseed Oil—Lower cables for the seed resulted in an easier market for the oil. The general demand was somewhat quiet and distributors showed more desire for new business, the situation being greatly in favor of the buyer. Spot oil sold around 87c. per gal. in carload lots. Foreign oil sold in a small way at 86c. per gallon.

Coconut Oil—The market was a shade higher during the week. Spot Ceylon type oil, in barrels, held around 8½c.

manufacturers of explosives and chemicals in general. Hence the production here reported is not to be taken as representing total production. The table shows for 1919 the percentage which the production of establishments primarily engaged in the manufacture of these acids constituted of the aggregate production reported for all industries. Corresponding figures for 1921 are not available.

per lb. November-December goods, for shipment from the coast, were quoted at 7½c. per lb., sellers' tanks.

Corn Oil—Crude oil on spot was in very limited supply and quotations were heard around 9½@10c. per lb.

Rapeseed Oil—Although the demand was considerably weaker than in the previous week, prices were firmly held. Spot was 77c. per gal. in barrels.

CRUDE RUBBER

The continued strong demand from leading consuming quarters resulted in a much firmer market on all grades. Sales of smoked sheets were reported at 22½c. per lb. on spot. Most interest was manifested in deliveries over the remainder of the year. Caucho ball, upper, was quoted at 18½@18½c. per lb. First latex crepe was also higher at 22½@22½c. per pound.

The Chicago Market

CHICAGO, Nov. 9, 1922.

The industrial chemical market continued firm, with a good volume of business reported from most quarters. The tendency on most items is toward higher prices, but buyers are still somewhat reluctant to purchase very far in advance of their immediate requirements. There are no large stocks of any items on hand and buyers are even experiencing some difficulty in locating supplies of certain materials. Freight from the East is quite slow, and this is a factor which makes spot material bring a greater premium than usual over the New York market.

GENERAL CHEMICALS

Caustic soda was unchanged in price, with the market reported firm and supplies moving in a good volume. The ground 76 per cent was available in most quarters at \$4.25 per 100 lb. and the solid at \$3.50. *Caustic potash* maintained its firm position and a good movement was reported at 7½c. per lb., basis 88-92 per cent. A good demand for *soda ash* was noted and the price was firm at \$2.25 per 100 lb. for moderate lots in coopersage.

Potash alum was rather scarce and spot material was firmly held. The iron-free lump was available in small lots at 5½c. per lb. and the powdered at 6½c. Barium compounds were slightly easier and fair-sized spot stocks were available. *Barium chloride* was offered in one direction at \$105 per ton and the *carbonate* from the same source at \$90. There was but little demand for the *barium hydrate crystals* and spot material was available at 6½c. per lb. *Sal ammoniac* was in fair demand and the price was firm at 7½@8c. per lb. for the white granular. *Ammonium carbonate* was quiet and spot material was quoted at 11c. per lb. in single-cask lots. *Bleaching powder* was in fair demand and the price was firm at \$2.60 per 100 lb. for drums. *Copper sulphate* was available in fair lots at 6c. per lb. *Carbon tetrachloride* was reported to be in good demand and the price was firm at 9½@10c. per lb. *Carbon bisulphide* was still scarce on spot and what was available was held at 7½c. per lb. Due to the greatly increased price of methanol the price on formaldehyde was sharply increased 15c. per lb. in single-barrel lots. Only moderate supplies were available and a good movement was reported. *Furfural* was quoted at 25c. per lb. in ton lots. *Glycerine* was a trifle unsteady, although refiners maintained the price at 18½c. per lb. for the c.p. material in drums. *Lead acetate* was in fair demand and the white granular was quoted at 12½c. per lb.

Bichromates maintained their firm position and were reported to be moving in a good volume. *Potassium bichromate* was available at 12@13c. per lb. and the *soda* at 9@9½c. *Potash carbonate*, calcined, 96-98 per cent, was quoted at 8½c. per lb. *Potash cyanide*

was very scarce on spot and small quantities only were available at 55@60c. per lb. *Potassium nitrate* was reported to be moving well and the double refined granular was offered at 7½c. per lb. delivered. *Permanganate of potash* was in fair request and supplies of the imported U.S.P. crystals were offered at 18@19c. per lb.

LINSEED OIL AND TURPENTINE

The market for linseed oil and turpentine was rather quiet the last 2 weeks and buyers were taking on only enough for their immediate requirements. *Turpentine* was slightly lower at the opening of today's market and single-drum lots were quoted at \$1.69 per gal. *Linseed oil* was quoted today at 90c. per gal. for the boiled in single-drum lots and 88c. for similar quantities of the raw.

The Iron and Steel Market

PITTSBURGH, Nov. 10, 1922.

The thirty steel companies which make monthly returns of their ingot production show 2,872,415 tons for October, against 2,373,779 tons for September, representing an increase of 21 per cent, each month having had 26 working days. Allowing for the producers not making monthly returns, the rate of production in October was about 40,000,000 tons a year, 9 per cent higher than the rate in June, hitherto the best month of the year. Last month's rate was, indeed, the highest since October, 1920.

A continuance of the October rate for this month and next would bring out a calendar year production of a trifle under 34,000,000 tons, 75 per cent above the production in 1921 and more than 10 per cent above production in either 1912 or 1913, the two greatest tonnage years before the war.

STEEL SHIPMENTS IN EXCESS OF PRODUCTION

During September the steel companies were recovering from the effects of the coal strike more rapidly than was currently assumed, and during October the estimates as to the production rate were below that now shown by the actual returns. In the circumstances the disappearance of delivery premiums on bars, shapes and plates and the decrease in delivery premiums on sheets, the other commodity that had been showing delivery premiums, is readily understood. Much has been said about shortages of cars at steel mills for shipping finished products, but it is known that the small accumulations that developed in September and the first week or so of October have since been reduced, so that shipments in October were in excess of production.

Taking a long range view of the year, one does not see the appearance of there being as heavy steel consumption, in most lines, as was in evidence in 1912 and 1913. The only conspicuous exception is the automobile industry, but its consumption does not represent

much more than 5 per cent of the total steel production. It is well to remember, as a collateral indication, that early in the year there was much disposition on the part of steel buyers to anticipate curtailment in steel production by the coal strike, and later it was fully expected that ending of the coal strike would be followed by such railroad congestion as would greatly interfere with the delivery of steel. In the retrospect it is plain that these influences have been of less amount than was expected.

WILL MILLS WITH LEAN ORDER BOOKS MAKE PRICE CONCESSIONS?

Having been under physical restrictions as to operations for many months, the steel mills are now anxious to operate and those that have relatively lean order books will be disposed to seek business by making price concessions. The advances in finished steel products from the low point early in March have been very divergent. Bars, shapes and plates, the cheapest commodities, have advanced about \$13 a ton. Tubular goods, a more finished product, have advanced a trifle less than \$10 a ton. Nails, at \$2.70, are up only \$6 a ton, except for there having been sales for a very short time at \$2.25. Tin plate, now \$4.75, has not advanced at all, except that early in the year the \$4.75 price was being shaded rather generally by independents. Sheets, taking the Steel Corporation price of 3.35c. as a basis, are up \$7 a ton from last March and \$12 a ton from September of last year.

FINISHED STEEL MARKETS QUIET

The finished steel markets are quiet all along the line, and some products are decidedly dull. All mills are well sold for the time being and some are sold far ahead. Buyers are covered, and thus there is no necessity for market activity at the moment. Buying in September was largely by consumers who were not receiving adequate deliveries on their old purchases.

PIG IRON AND COKE

Production of merchant pig iron is now about one-half greater than it was in August. Deliveries are chiefly on old orders, there being very little current buying. Prices are, of course, in process of liquidation, but they decline slowly both because furnaces have old contracts they wish to protect and because, in the absence of important inquiry, energetic price competition is not promoted. Foundry iron has sagged \$1 in the week, being now at \$29 valley, while bessemer could probably be bought at \$32 valley, \$1 decline. Basic has shown no development and remains quotable at \$29 valley.

Connellsville coke experienced another sudden weakening in the first 2 days of this week, losing 50c. to 75c. in furnace and about \$2 in foundry. Furnace coke for spot shipment is \$7.25@7.50 and for shipment next week \$7@7.25, while foundry is \$8@9 according to brand. Production continues to increase. Furnaces now in blast are largely covered to the end of the year.

General Chemicals

Current Wholesale Prices in New York Market

		Carlots F.o.b. N. Y.	Less Carlots F.o.b. N. Y.
Acetic anhydride	lb.		
Acetone	lb.	\$0.19 - \$0.20	\$0.38 - \$0.40
Acid, acetic, 28 per cent	100 lb.	2.92 - 3.00	3.05 - 3.20
Acetic, 56 per cent	100 lb.	5.85 - 5.90	5.95 - 6.25
Acetic, glacial, 99 1/2 per cent, carboys	100 lb.	11.16 - 11.20	11.25 - 11.50
Boric, crystals	lb.	11 - 11 1/2	11 1/2 - 12
Boric, powder	lb.	11 - 11 1/2	11 1/2 - 12
Citric	lb.	51 - 52	51 - 52
Hydrochloric	100 lb.	90 - 1.00	1.10 - 1.40
Hydrofluoric, 52 per cent	lb.	11 - 11 1/2	11 1/2 - 12
Lactic, 44 per cent tech.	lb.	11 - 11 1/2	11 1/2 - 12
Lactic, 22 per cent tech.	lb.	06 - 06 1/2	06 1/2 - 07
Molybdic, c.p.	lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric)	lb.	05 - 05 1/2	06 - 06 1/2
Nitric, 40 deg.	lb.	06 - 06 1/2	06 1/2 - 07
Nitric, 42 deg.	lb.	15 - 15 1/2	15 1/2 - 16
Oxalic, crystals	lb.	07 1/2 - 08	08 - 09
Phosphoric, 50 per cent solution	lb.	20 - 22	23 - 27
Picric	lb.		1.65 - 1.75
Pyrogallol, resublimed	ton	9.00 - 10.00	
Sulphuric, 60 deg., tank cars	ton	12.00 - 14.00	
Sulphuric, 60 deg., drums	ton	14.50 - 15.00	
Sulphuric, 66 deg., tank cars	ton	19.00 - 20.00	20.50 - 21.00
Sulphuric, 66 deg., drums	ton		
Sulphuric, fuming, 20 per cent (oleum)	ton	19.00 - 20.00	
Sulphuric, fuming, 20 per cent (oleum)	ton	22.00 - 22.50	23.00 - 24.00
Sulphuric, fuming, 20 per cent (oleum)	ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.	lb.		60 - 75
Tannic (tech.)	lb.	40 - 45	46 - 50
Tartaric, imported crystals	lb.		31 - 31 1/2
Tartaric acid, imported, powdered	lb.		31 - 32
Tartaric acid, domestic	lb.		1.00 - 1.10
Tungstic, per lb. of WO ₃	gal.		4.75 - 4.95
Alcohol, ethyl (Cologne spirit)	gal.		36 - 38
Alcohol, methyl (see methanol)	gal.		36 - 38
Alcohol, denatured, 188 proof No. 1	gal.		04 - 04 1/2
Alcohol, denatured, 188 proof No. 5	gal.		04 - 04 1/2
Alum, ammonia, lump	lb.	03 1/2 - 03 1/2	04 - 04 1/2
Alum, potash, lump	lb.	03 1/2 - 03 1/2	04 - 04 1/2
Alum, chrome lump	lb.	05 - 05 1/2	05 1/2 - 06
Aluminum sulphate, commercial	100 lb.	1.50 - 1.65	1.70 - 2.25
Aluminum sulphate, iron free	lb.	02 1/2 - 02 1/2	03 - 03 1/2
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	06 - 07	07 - 08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	30 - 30 1/2	30 1/2 - 31
Ammonium carbonate, powder	lb.	08 - 08 1/2	09 - 09 1/2
Ammonium nitrate	lb.	06 - 06 1/2	06 1/2 - 07
Amylacetate tech.	gal.		2.35 - 2.50
Arsenic, white, powdered	lb.	11 1/2 - 12	11 1/2 - 12
Arsenic, red, powdered	lb.	12 - 12 1/2	13 - 13 1/2
Barium carbonate	ton	75.00 - 77.00	78.00 - 80.00
Barium chloride	ton	95.00 - 100.00	102.00 - 105.00
Barium dioxide (peroxide)	lb.	20 - 21	21 1/2 - 22
Barium nitrate	lb.	09 - 09 1/2	09 1/2 - 10
Barium sulphate (precip.) (blanc fixe)	lb.	04 - 04 1/2	04 1/2 - 04 3/4
Blanc fixe, dry	lb.	04 - 04 1/2	
Blanc fixe, pulp	ton	45.00 - 55.00	
Bleaching powder	100 lb.	2.00 - 2.10	2.15 - 3.25
Blue vitriol (see copper sulphate)	lb.	05 1/2 - 05 1/2	06 - 06 1/2
Borax	lb.		28 - 35
Bromine	lb.	27 - 38	28 - 35
Calcium acetate	100 lb.	3.00 - 3.15	3.20 - 3.50
Calcium carbide	lb.	04 - 04 1/2	05 - 05 1/2
Calcium chloride, fused, lump	ton	22.00 - 23.00	23.50 - 27.00
Calcium chloride, granulated	lb.	01 1/2 - 01 1/2	02 - 02 1/2
Calcium peroxide	lb.		1.40 - 1.50
Calcium phosphate, tribasic	lb.		15 - 16
Camphor	lb.		88 - 90
Carbon bisulphide	lb.	07 - 07 1/2	07 1/2 - 07 3/4
Carbon tetrachloride, drums	lb.	10 - 10 1/2	10 1/2 - 12
Carbonyl chloride, (phosgene)	lb.		60 - 75
Caustic potash (see sodium hydroxide)	lb.		
Caustic soda (see sodium hydroxide)	lb.		
Chalk, precip.—domestic, light	lb.	04 - 04 1/2	
Chalk, precip.—domestic, heavy	lb.	03 - 03 1/2	
Chalk, precip.—imported, light	lb.	04 - 05	
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	05 1/2 - 06	06 1/2 - 06 3/4
Chloroform	lb.		35 - 38
Cobalt oxide	lb.		2.10 - 2.40
Copperas	ton	27.00 - 28.00	29.00 - 30.00
Copper carbonate, green precipitate	lb.	21 - 21 1/2	22 - 22 1/2
Copper cyanide	lb.		58 - 600
Copper sulphate, crystals	100 lb.	5.75 - 6.00	6.10 - 6.504
Cream of tartar	lb.		25 - 26
Epom salt (see magnesium sulphate)	lb.		72 - 75
Ethyl acetate com. 85%	gal.		90 - 95
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.		14 - 14 1/2
Formaldehyde, 40 per cent	gal.	14 - 14 1/2	
Fullers earth, f.o.b. mines	net ton	16.00 - 17.00	
Fullers earth—imported powdered	net ton	30.00 - 32.00	
Fuel oil, ref.	gal.		2.75 - 2.90
Fuel oil, crude	gal.		1.65 - 1.85
Glauber's salt (see sodium sulphate)	lb.		18 - 18 1/2
Glycerine, c.p., drums extra	lb.		4.40 - 4.50
Iodine, resublimed	lb.		12 - 18
Iron oxide, red	lb.		12 - 12 1/2
Lead acetate, white crystals	lb.	13 - 13 1/2	13 1/2 - 14
Lead arsenate, powd.	lb.		15 - 20
Lead nitrate	lb.	07 1/2 - 08	08 1/2 - 09
Litharge	lb.	06 - 06 1/2	06 1/2 - 07 1/2
Magnesium carbonate, technical	lb.	2.50 - 2.65	2.70 - 3.50
Magnesium sulphate, U.S.P.	100 lb.		1.00 - 1.80
Magnesium sulphate, technical	100 lb.		90 - 92
Methanol, 95%	gal.		92 - 94
Methanol, 97%	gal.		11 - 11 1/2
Nickel salt, double	lb.		

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Nickel salt, single	lb.		\$0.12 - \$0.12 1/2
Phosgene (see carbonyl chloride)	lb.		40 - 45
Phosphorus, red	lb.		30 - 35 1/2
Phosphorus, yellow	lb.		101 - 11
Potassium bichromate	lb.	\$0.10 - 10 1/2	17 - 23
Potassium bromate, granular	lb.		13 - 16
Potassium carbonate, U. S. P.	lb.	12 - 12 1/2	06 1/2 - 06 3/4
Potassium carbonate, 80-85%	lb.	06 - 06 1/2	08 1/2 - 09
Potassium chlorate, powdered and crystals	lb.	07 1/2 - 08	55 - 57
Potassium cyanide	lb.		6.60 - 7.00
Potassium hydroxide (caustic potash)	100 lb.	6.25 - 6.50	3.45 - 3.55
Potassium iodide	lb.	06 1/2 - 06 3/4	07 - 08
Potassium nitrate	lb.	16 1/2 - 16 3/4	17 - 17 1/2
Potassium permanganate	lb.		90 - 95
Potassium prussiate, red	lb.	38 - 38 1/2	38 1/2 - 38 3/4
Potassium prussiate, yellow	lb.		
Rochelle salts (see sodium potas. tartrate)	lb.	06 1/2 - 06 3/4	07 - 07 1/2
Salammoniac, white, granular	lb.	08 - 08 1/2	08 1/2 - 08 3/4
Salammoniac, gray, granular	lb.	1.20 - 1.40	1.45 - 1.60
Salsoda	100 lb.		
Salt cake (bulk)	ton	25.00 - 27.00	
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.60 - 1.67	2.00 - 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.75 - 1.80	1.85 - 2.35
Soda ash, dense, in bags, resale	100 lb.	1.85 - 1.90	1.95 - 2.40
Sodium acetate	lb.	07 1/2 - 08	08 1/2 - 08 3/4
Sodium bicarbonate	100 lb.	1.75 - 1.85	1.90 - 2.30
Sodium bichromate	lb.	07 1/2 - 07 3/4	08 - 08 1/2
Sodium bisulphate (nitre cake)	ton	4.50 - 4.60	4.65 - 5.50
Sodium bisulphite powdered, U.S.P.	lb.	04 1/2 - 04 3/4	04 3/4 - 05 1/2
Sodium chloride	lb.	06 1/2 - 07	07 1/2 - 07 3/4
Sodium chloride, long ton	ton	12.00 - 13.00	
Sodium cyanide	lb.	19 1/2 - 21	21 - 25
Sodium fluoride	lb.	09 1/2 - 10	10 1/2 - 10 3/4
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 - 3.40	3.75 - 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.60 - 3.65	3.70 - 4.00
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.80 - 3.90	4.25 - 4.40
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 - 4.15	4.40 - 4.60
Sodium hyposulphite	lb.	02 1/2 - 02 3/4	03 - 03 1/2
Sodium nitrite	lb.	09 - 09 1/2	09 1/2 - 10
Sodium peroxide, powdered	lb.	28 - 30	31 - 35
Sodium phosphate, dibasic	lb.	03 1/2 - 04	04 1/2 - 04 3/4
Sodium potassium tartrate (Rochelle salts)	lb.		18 - 21
Sodium prussiate, yellow	lb.	21 1/2 - 22	22 1/2 - 22 3/4
Sodium silicate, (40 deg. in drums)	100 lb.	80 - 1.00	1.05 - 1.25
Sodium silicate, (60 deg. in drums)	100 lb.	2.25 - 2.40	2.45 - 2.75
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	lb.	85 - 95	1.00 - 1.40
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	04 - 04 1/2	04 1/2 - 05
Sodium sulphite, crystals	lb.	03 1/2 - 03 3/4	03 3/4 - 04 1/2
Strontium nitrate, powdered	lb.	09 - 10	10 - 12
Sulphur chloride, yellow	lb.	04 1/2 - 05	05 1/2 - 06
Sulphur, crude	ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra	lb.	08 - 08 1/2	09 - 10
Sulphur (sublimed), flour	100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)	100 lb.	2.00 - 2.15	2.20 - 2.70
Talc—imported	ton	30.00 - 40.00	
Talc—domestic powdered	ton	18.00 - 25.00	
Tin bichloride	lb.	10 - 10 1/2	10 1/2 - 10 3/4
Tin oxide	lb.		43 - 45
Zinc carbonate	lb.	14 - 14 1/2	14 1/2 - 15 1/2
Zinc chloride, gran.	lb.	07 - 07 1/2	07 1/2 - 08
Zinc cyanide	lb.	42 - 44	45 - 47
Zinc oxide, XX	lb.	07 1/2 - 08	08 1/2 - 08 3/4
Zinc sulphate	100 lb.	2.75 - 3.00	3.05 - 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	\$0.95 - \$1.00
Alpha-naphthol, refined	lb.	1.10 - 1.15
Alpha-naphthylamine	lb.	29 - 31
Aniline oil, drums extra	lb.	16 1/2 - 17
Aniline salts	lb.	22 - 24
Anthracene, 80% in drums (100 lb.)	lb.	75 - 1.00
Benzaldehyde U.S.P.	lb.	1.25 - 1.35
Benzene, pure, water-white, in drums (100 gal.)	gal.	30 - 35
Benzene, 90%, in drums (100 gal.)	gal.	28 - 32
Benzidine, base	lb.	85 - 95
Benzidine sulphate	lb.	80 - 85
Benzoic acid, U.S.P.	lb.	72 - 75
Benzoate of soda, U.S.P.	lb.	57 - 65
Benzyl chloride, 95-97%, refined	lb.	25 - 27
Benzyl chloride, tech.	lb.	20 - 23
Beta-naphthol benzoate	lb.	3.75 - 4.00
Beta-naphthol, sublimed	lb.	53 - 55
Beta-naphthol, tech.	lb.	25 - 26
Beta-naphthylamine, sublimed	lb.	1.50 - 1.60
Carbazol	lb.	75 - 90
Cresol, U. S. P., in drums (100 lb.)	lb.	14 - 20
Ortho-cresol, in drums (100 lb.)	lb.	18 - 22
Cresylic acid, 97-99%, straw color, in drums	gal.	60 - 65
Cresylic acid, 95-97%, dark, in drums	gal.	55 - 58
Dichlorobenzene	lb.	06 - 09
Diethylaniline	lb.	50 - 60
Dimethylaniline	lb.	34 - 36
Dinitrobenzene	lb.	20 - 22
Dinitrochlorobenzene	lb.	21 - 22
Dinitronaphthalene	lb.	30 - 32
Dinitrophenol	lb.	32 - 34
Dinitrotoluene	lb.	22 - 24
Dip oil, 25%, car lots, in drums	gal.	85 - 90
Diphenylamine	lb.	54 - 56
H-acid	lb.	72 - 75
Meta-phenylenediamine	lb.	90 - 1.00
Monochlorobenzene	lb.	08 - 10
Monothylaniline	lb.	95 - 1.10
Naphthalene crushed, in bbls.	lb.	06 - 06 1/2
Naphthalene, flake	lb.	06 1/2 - 07
Naphthalene, balls	lb.	07 1/2 - 08
Naphthionate of soda	lb.	58 - 65
Naphthionic acid, crude	lb.	65 - 70
Nitrobenzene	lb.	10 - 12

Nitro-naphthalene.....	lb.	\$0.30	—	\$0.35
Nitro-toluene.....	lb.	.15	—	.10
N-W acid.....	lb.	1.20	—	1.30
Ortho-amidophenol.....	lb.	2.25	—	2.30
Ortho-dichlor-benzene.....	lb.	.17	—	.20
Ortho-nitro-phenol.....	lb.	.80	—	.85
Ortho-nitro-toluene.....	lb.	.12	—	.15
Ortho-toluidine.....	lb.	.12	—	.14
Para-amidophenol, base.....	lb.	1.20	—	1.25
Para-amidophenol, HCl.....	lb.	1.25	—	1.30
Para-dichlorbenzene.....	lb.	.17	—	.20
Paranitroaniline.....	lb.	.72	—	.80
Para-nitrotoluene.....	lb.	.55	—	.65
Para-phenylenediamine.....	lb.	1.55	—	1.60
Para-toluidine.....	lb.	.85	—	.90
Phthalic anhydride.....	lb.	.35	—	.38
Phenol, U. S. P., drums.....	lb.	.32	—	.35
Pyridine.....	gal.	1.60	—	1.75
Resorcinol, technical.....	lb.	1.50	—	1.55
Resorcinol, pure.....	lb.	2.00	—	2.10
R-salt.....	lb.	.55	—	.60
Salicylic acid, tech., in bbls.....	lb.	.33	—	.35
Salicylic acid, U. S. P.....	lb.	.38	—	.40
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.27	—	.32
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.12	—	.14
Sulphanilic acid, crude.....	lb.	.24	—	.26
Tolidine.....	lb.	1.20	—	1.30
Toluidine, mixed.....	lb.	.30	—	.35
Toluene, in tank cars.....	gal.	.25	—	.28
Toluene, in drums.....	gal.	.30	—	.35
Xylidines, drums, 100 gal.....	lb.	.40	—	.45
Xylene, pure, in drums.....	gal.	.40	—	.45
Xylene, pure, in tank cars.....	gal.	.45	—	.50
Xylene, commercial, in drums, 100 gal.....	gal.	.33	—	.35
Xylene, commercial, in tank cars.....	gal.	.30	—	....

Waxes

Prices Remain Quotably Unchanged.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$6.60	—	....
Rosin E-I.....	280 lb.	6.65	—	....
Rosin K-N.....	280 lb.	6.75	—	\$7.15
Rosin W. G.-W. W.....	280 lb.	7.75	—	8.25
Wood rosin, bbl.....	280 lb.	6.25	—	....
Spirits of turpentine.....	gal.	1.60	—	1.61
Wood turpentine, steam dist.....	gal.	1.35	—	....
Wood turpentine, dest. dist.....	gal.	1.25	—	....
Pine tar pitch, bbl.....	200 lb.	....	—	6.00
Tar, kiln burned, bbl (500 lb.).....	bbl.	....	—	12.50
Retort tar, bbl.....	500 lb.	....	—	11.00
Rosin oil, first run.....	gal.	.43	—	....
Rosin oil, second run.....	gal.	.51	—	....
Rosin oil, third run.....	gal.	.53	—	....
Pine oil, steam dist., sp.gr., 0.930-0.940.....	gal.	.90	—	....
Pine oil, pure, dest. dist.....	gal.	.85	—	....
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46	—	....
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35	—	....
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75	—	....
Pine tar, ref., thin, sp.gr., 1.080-1.060.....	gal.	.25	—	....
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990.....	gal.	.25	—	....
Pinewood creosote, ref.....	gal.	.52	—	....

Fertilizers

Ammonium sulphate, f.a.s., N. Y., double bags... 100 lb. 3.60 — 3.70

All Other Quotations Remain Same as Previous Report.

Crude Rubber

Para-Upriver fine.....	lb.	\$0.24	—	.24
Upriver coarse.....	lb.	.18	—	.19
Upriver cauchó ball.....	lb.	.18	—	.18
Plantation—First latex crepe.....	lb.	.22	—	.23
Ribbed smoked sheets.....	lb.	.22	—	.23
Brown crepe, thin, clean.....	lb.	.20	—	.20
Amber crepe No. 1.....	lb.	.20	—	.20

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.12	—	\$0.12
Castor oil, AA, in bbls.....	lb.	.12	—	.13
China wood oil, in bbls.....	lb.	.12	—	.13
Cocunut oil, Ceylon grade, in bbls.....	lb.	.08	—	.08
Cocunut oil, Cochín grade, in bbls.....	lb.	.08	—	.09
Corn oil, crude, in bbls.....	lb.	.09	—	.10
Cottonseed oil, crude (f. o. b. mill).....	lb.	.08	—	....
Cottonseed oil, summer yellow.....	lb.	.11	—	.11
Cottonseed oil, winter yellow.....	lb.	.12	—	.12
Linseed oil, raw, car lots (domestic).....	gal.	.87	—	.88
Linseed oil, raw, tank cars (domestic).....	gal.	.84	—	.85
Linseed oil, boiled, in 5-bbl lots (domestic).....	gal.	.88	—	.90
Olive oil, denatured.....	gal.	1.15	—	1.17
Palm, Lagos.....	lb.	.07	—	.07
Palm, Niger.....	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.09
Peanut oil, refined, in bbls.....	lb.	.12	—	.13
Rapeseed oil, refined in bbls.....	gal.	.77	—	.78
Rapeseed oil, blown, in bbls.....	gal.	.84	—	.85
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.11	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.09	—	.09

Miscellaneous Materials

Asbestos, crude No. 1, f.o.b., Quebec, Canada.....	short ton	\$600.00	—	\$800.00
Asbestos, shingle stock, f.o.b., Quebec, Canada.....	short ton	65.00	—	80.00
Asbestos, cement stock, f.o.b., Quebec, Canada.....	short ton	15.00	—	17.00
Barytes, ground, white, f.o.b. mills.....	net ton	17.00	—	23.00
Barytes, ground, off color f.o.b. mills.....	net ton	13.00	—	21.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude f.o.b. mines.....	net ton	8.00	—	9.00
Casein.....	lb.	.10	—	.13
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.00	—	8.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	8.00	—	9.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	14.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	14.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	40.00	—	45.00
Feldspar, No. 1 pottery grade.....	long ton	6.50	—	7.00
Feldspar, No. 2 pottery grade.....	long ton	4.00	—	5.50
Feldspar, No. 1 soap grade.....	long ton	7.00	—	7.50
Feldspar, No. 1 Canadian, for mill.....	long ton	20.00	—	21.00
Graphite, Ceylon lump, first quality, f.o.b. N. Y.....	lb.	.05	—	.05
Graphite, Ceylon chip.....	lb.	.04	—	.04
Graphite, high grade amorphous crude.....	ton	35.00	—	50.00
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	....
Kieselguhr, f.o.b. N. Y.....	per ton	50.00	—	55.00
Magnesite, crude, f.o.b. California mines.....	per ton	12.00	—	15.00
Pumice stone, imported.....	lb.	.03	—	.05
Pumice stone, domestic, lump.....	lb.	.05	—	.05
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Shellac, orange fine.....	lb.	.66	—	.68
Shellac, orange superfine.....	lb.	.68	—	.70
Shellac, A. C. garnet.....	lb.	.70	—	.72
Shellac, T. N.....	lb.	.65	—	.66
Silica, glass sand, f.o.b. Indiana.....	per ton	1.75	—	2.50
Silica, sand blast material, f.o.b. Indiana.....	per ton	2.50	—	5.00
Silica, amorphous, 250 mesh, f.o.b. Illinois.....	per ton	17.00	—	17.50
Silica, building sand, f.o.b. Pa.....	per ton	2.00	—	2.75
Soapstone.....	ton	12.00	—	15.00
Talc, 200 mesh, f.o.b. Vermont.....	ton	7.00	—	12.00
Talc, 200 mesh, f.o.b. Georgia.....	ton	7.50	—	12.00
Talc, 200 mesh, f.o.b. Los Angeles.....	ton	15.00	—	17.00

Refractories

Quotations Remain Same as Previous Report.

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried, f.o.b. shipping points.....	net ton	\$6.00	—	\$9.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , c.i.f. Atlantic seaboard.....	ton	19.00	—	20.00
Coke, foundry, f.o.b. ovens.....	net ton	10.00	—	10.50
Coke, furnace, f.o.b. ovens.....	net ton	7.50	—	8.00
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	15.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	17.50	—	19.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	45	—	....
Manganese ore, chemical (MnO ₂).....	net ton	75.00	—	80.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.80	—	.85
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	27.00	—	....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.10	—	.11
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.12	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	Nominal	—	....
Rutile, 95% TiO ₂ , per lb. ore.....	lb.	.12	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	8.00	—	8.25
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	7.75	—	8.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04	—	.13

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

Copper, electrolytic.....		Cents per Lb.	13.80
Aluminum, 98 to 99 per cent.....		20.00-21.00	
Antimony, wholesale lots, Chinese and Japanese.....		6.60	
Nickel, ordinary (ingot).....		36.00	
Nickel, electrolytic.....		39.00	
Nickel, electrolytic, resale.....		32.00-33.00	
Nickel, ingot and shot, resale.....		30.00-31.00	
Monel metal, shot and blocks.....		32.00	
Monel metal, ingots.....		35.00	
Monel metal, sheet bars.....		38.00	
Tin, 5-ton lots, Straits.....		37.00	
Lead, New York, spot.....		7.00	
Lead, E. St. Louis, spot.....		6.80-6.85	
Zinc, spot, New York.....		7.40-7.45	
Zinc, spot, E. St. Louis.....		7.05	

OTHER METALS

Silver (commercial).....	oz.	\$0.66	
Cadmium.....	lb.	1.15	
Bismuth (500 lb. lots).....	lb.	2.45	
Cobalt.....	lb.	3.00@3.25	
Magnesium, ingots, 99 per cent.....	lb.	1.00@1.05	
Platinum.....	oz.	\$108.00	
Iridium.....	oz.	240.00@275.00	
Palladium.....	oz.	52.00@55.00	
Mercury.....	75 lb.	72.00	

Industrial

Financial. Construction and Manufacturers' News

Industrial Developments

GLASS—The Wichita Falls Window Glass Co., Wichita Falls, Tex., has resumed operations at its plant after a shut-down for the past 5 months, during which time extensions were made in a number of departments, with considerable repairs to machinery. Employment will be given to about 160 men.

The Pioneer Window Glass Works, Marietta, O., recently acquired by John B. Yates, vice-president of the Premier Glass Co., Pennsboro, W. Va., will resume production early in January. Improvements will be made in plant and equipment.

All glass plants are now in operation at Okmulgee, Okla., with the exception of the Graham Glass Co., specializing in the manufacture of bottles. The active factories include the Southwestern Sheet Glass Co., running at maximum output; the Interstate Window Glass Co., and the Baker Brothers Glass Co.

Plate and bottle glass plants in Belgium are now running full, with sufficient orders on hand to insure continuous production for some months. Crystal plants are operating under considerable curtailed output. Window glass plants are advancing manufacture and 20 furnaces are now producing, the largest number since the close of the war.

PAPER—The Forest Paper Co., Yarmouth, Me., is arranging for the immediate resumption of operations at its local plant, which has been inactive since early in March. Employment will be given to a near-normal working force, with increased wage scale.

The Fort Wayne Corrugated Paper Co., Fort Wayne, Ind., is maintaining full production at its mill at Hartford City, Ind., and has advanced the wage scale 10 per cent.

CERAMIC—The Thomas Maddock's Sons Co., Trenton, N. J., manufacturer of sanitary ware, is maintaining operations at its plant on a reduced working schedule, following a strike of skilled potters, affiliated with the union, due to a refusal to grant the wage increase demand of 20 per cent. Unskilled workers are being added to the force on a basis of 60 cents an hour for a 9-hour day, and guarantee of \$40 a week for an 8-hour day in a few months after they become proficient.

A total of about 10,000 operative potters are out at the sanitary ware plants at Trenton, N. J., following the refusal of employers to meet a demand for a wage advance of 20 per cent. A total of 16 potteries in this city is affected.

The Elite Pottery Co. and the Van Pottery Co., Trenton, N. J., have resumed production at their sanitary ware plants, following an agreement with operatives for a 20 per cent wage increase, effective Nov. 1. Other plants that have met the demands of the men are the Ironsides Pottery Co., Bordentown, N. J.; Penn Pottery Co., Philadelphia, Pa.; Potomac Valley Pottery Co., Keyser, W. Va.; Wooster Sanitary Mfg. Co., Fredericksburg, O., and Clarksburg, W. Va.; and the Westcoast Sanitary Mfg. Co., Milbrae, Cal.

IRON AND STEEL—The Gulf States Steel Co., Birmingham, Ala., is maintaining capacity operations at 4 open-hearth mills and all finishing mills, with employment of regular working force.

The Carnegie Steel Co. is arranging for the immediate resumption of operations at its bar mill at Sharon, Pa.

The Pulaski Furnace Co., Pulaski, Va., is preparing to blow in its local blast furnace. The plant will advance production further at an early date.

The Woodward Iron Co., Birmingham, Ala., is now running full at all of its 5 blast furnaces for the first time in a number of years. Four of the stacks are producing foundry pig and the other basic material for Western steel mills.

The American Sheet & Tin Plate Co., Sharon, Pa., is arranging to start up at 10 additional hot mills at its local plant, making a total of 25 out of 30 in service. The working force will be increased by about 700 men.

The wage scale of union puddlers, Youngstown, O., has been increased from \$8.93 to \$10.12 a ton.

The Bethlehem Steel Co., Bethlehem, Pa., is now operating at about 80 per cent of capacity at its different mills.

All plants of the United States Steel Corp., in the vicinity of Sharon, Pa., are operating at normal production, giving employment to about 6,000 men.

The Crucible Steel Co., Syracuse, N. Y., is maintaining production on a 100 per cent basis. It is said that orders on hand insure continuance for a number of months to come.

METALS—The American Smelting & Refining Co. is making ready for the immediate blowing in of its furnaces at the Monterey, Mexico, plant. Employment will be given to more than 2,000 workers.

The Hercules Mining Co., Burke, Idaho, is planning for an immediate increase in production at its local plant, with important additions in the working force.

The Callahan Zinc-Lead Co., Coeur d'Alene, Idaho, has resumed production at its local plant after a shut down of about 24 months. The working force will be increased gradually until the regular quota of 350 men is obtained.

The Monterey Iron & Steel Co., Monterey, Mexico, is running full in all departments of its local mills.

MISCELLANEOUS—Fiber plants at Newark, Yorklyn, New Castle and Stanton, Del., are advancing production, with an increase of from 5 to 10 per cent in working force. Eight plants at Wilmington, Del., are now giving employment to approximately 2,000 workers.

The H. C. Frick Coke Co., Connellsville, Pa., is developing capacity production at its local plants, and is running higher than at any time since December, 1920.

The Corn Products Refining Co. is arranging to advance production to 85 per cent and higher at its refineries at Edgewater, N. J., Pekin and Argo, Ill., as compared with about 65 per cent of capacity during the past month. Plants are being improved and extended.

The Acme Mfg. Co., Acme, N. C., is arranging for capacity production at its fertilizer-manufacturing plant, following extensive additions and improvements.

All cement mills in the Lehigh Valley district of Pennsylvania are running at full capacity, with practically no reserves on hand. Current orders are absorbing all present production.

The United States Industrial Alcohol Co., Baltimore, Md., is operating at full capacity at all plants. New equipment for the production of high-grade alcohol for motor fuel has recently been placed in service at the Curtis Bay works.

Construction and Operation

Arkansas

EL DORADO—The Lion Oil & Refining Co., Kansas City, Mo., plans for extensions and improvements in its refinery at El Dorado, including the installation of new processing equipment. F. W. Thwing is president, and Victor H. Smith vice-president and general manager.

California

SAN FRANCISCO—The San Francisco Sulphur Co., 624 California St., has completed plans for the construction of a new 1-story sulphur-refining plant, 137x138 ft., on West Grant Ave., to cost approximately \$35,000. P. M. Paulson, 624 California St., is architect.

LOS ANGELES—The Buckley Milling Corp., a foreign organization has acquired property at San Pedro Harbor, Los Angeles, as a site for a new metal smelting and refining plant. A rolling mill is also planned, with miscellaneous plant structures. Gordon E. Vance, vice-president, and Edgar T. Carlstorm, consulting engineer, are opening local

headquarters for the company, and have commenced preliminary plans. The new plant is estimated to cost in excess of \$1,000,000.

SAN FRANCISCO—The Goodrich Rubber Co., 401 Mission St., has completed plans and will soon commence the construction of a new 6-story building, 65x160 ft., estimated to cost about \$150,000, including equipment. H. C. Baumann, 251 Kearny St., is architect.

Georgia

SAVANNAH—Preliminary plans are being drawn by the Dunlevi Lumber Co. Inc., for the construction of a new turpentine extraction plant, in connection with extensions in its mills in Liberty and McIntosh counties. The company was recently reorganized, with E. V. Dunlevi as president.

Illinois

EAST ALTON—The Western Cartridge Co. has awarded a contract to the Wimmer Construction Co., Victoria Bldg., St. Louis, Mo., for the construction of its proposed 1-story brass mill addition, 86x240 ft., to cost in excess of \$50,000, including equipment. Work will be placed under way at once.

Indiana

HARTFORD CITY—The Fort Wayne Corrugated Paper Co., Murray and Barr Sts., Fort Wayne, has preliminary plans in progress for the construction of a 1- and 2-story addition to its plant at Hartford City. Bids will be called at an early date. Mills, Rhines, Bellman & Nordhoff, 1234 Ohio Bldg., Toledo, O., are architects.

NOBLESVILLE—The New Process Steel Co. has arranged for immediate operations at the first unit of its new local plant, to be used for the production of steel billets and kindred products. Work is under way on three other plant units, and the structures will be ready for service early in the coming year. Employment will be given to about 200 operatives. J. E. Owen is vice-president, and James Hundley general manager.

EAST CHICAGO—The Jones & Laughlin Steel Co., Pittsburgh, Pa., has preliminary plans nearing completion for the construction of the initial buildings for its proposed new steel mill on local site, recently acquired. It is estimated to cost in excess of \$2,000,000.

EVANSVILLE—A 1-story plant, 45x160 ft., for the manufacture of mirrors and other glass products will be constructed at the works of the Globe-Bosse-World Furniture Co. It is estimated to cost about \$25,000. Russ & Karges, Furniture Bldg., are architects.

EDINBURG—The Union Starch & Refining Co., operating a local plant, has acquired the factory of the Temtor Corn & Fruit Products Co. at Granite City, Ill., and will concentrate operations at the latter point. Immediate possession will be taken, and necessary improvements made for a complete refinery, to develop an output more than double that of the Edinburg plant. William G. Irwin is president.

Kansas

PHILLIPSBURG—The City Clerk is taking bids until Nov. 20 for the construction of a new filtration plant at the municipal water works, including the installation of complete equipment. Black & Veatch, Mutual Bldg., Kansas City, Mo., are engineers.

Louisiana

MONROE—The Cosmos Carbon Co., Charleston, W. Va., has acquired the local plant of the Oscar Nelson Co. and will take immediate possession. It is proposed to make extensions and improvements and use the works for the production of carbon black and kindred specialties.

STERLINGTON—The Imperial Oil & Gas Products Corp. has plans in progress for extensions and improvements in its local plant to cost about \$150,000, including machinery. A primary feature of the work will include a department for the production of carbon.

Maryland

BALTIMORE—The Locke Insulator Corp., Charles and Cromwell Sts., manufacturer of porcelain insulators, has filed plans for the construction of a new 1-story kiln building, 18x55 ft., to cost about \$20,000. Work will be commenced at once.

Massachusetts

MALDEN—Wadsworth, Howland & Co. Inc., 139 Federal St., Boston, manufacturer of paint, varnishes, etc., has filed plans for

the construction of a new building at its local plant on Green St., estimated to cost about \$95,000.

AMHERST—The State Agricultural College is pushing construction work on its new 3-story chemical laboratory building, 45x111 ft., estimated to cost approximately \$300,000, and plans to place the structure in service immediately upon completion. Ritchie, Parsons & Taylor, 15 Ashburton Pl., Boston, are architects.

Michigan

MONROE—The Republic Glass Co. has work under way on the installation of machinery at its new local plant, recently completed, and purposes to place the works in service before the close of the month. It will specialize in the manufacture of automobile lenses and other kindred glass products. Manuel Liera is president and general manager.

TAYLORVILLE—The Kalamazoo Stationary Co., Kalamazoo, has preliminary plans in progress for enlargements at the former paper mill of the E-Z Bag Co., recently acquired, for a consideration of about \$40,000. It is proposed to double the present capacity, providing equipment for the employment of about 500 operatives.

FLAT ROCK—In connection with its proposed local plant for the manufacture of sheet glass products, the Ford Motor Co., Highland Park, will construct a large gas producer plant, for which plans are nearing completion. The entire works will cost approximately \$1,500,000. Albert Kahn, 1000 Marquette Bldg., Detroit, is architect.

Minnesota

MINNEAPOLIS—The Lavoris Chemical Co., Western Ave., will break ground at once for the construction of its proposed 3-story plant at 910-22 3rd St., North, for which a general contract recently was awarded. It is expected to have the factory equipped and ready for service early in the spring. It is estimated to cost about \$120,000. W. H. Leving is secretary and treasurer.

Nevada

RENO—The local Chamber of Commerce has plans in progress for the construction of a local plant for the manufacture of commercial fertilizer, with initial capacity of approximately 10,000 tons per annum. It is proposed to organize a company to operate the mill.

New Jersey

IRVINGTON—The Clinton Chemical Corp., 1047 Clinton Ave., Irvington, Newark, recently organized, has tentative plans under consideration for the construction of a new plant. The company will operate with a capital of \$100,000.

BELLEVILLE—Daniel A. Higgins, manufacturer of dyes, chemical specialties, etc., has acquired the local plant of the Thomson Machine Co., 298 Main St., for a consideration of \$28,000. The structure comprises about 19,000 ft. of floor space and will be used by the owner for general manufacture.

New York

LONG ISLAND CITY—The E. Virgil Neal Chemical Works, 11 East 30th St., New York, has acquired the 3-story factory at Borden Ave. and VanDam St., heretofore occupied under lease. Operations will be continued permanently at this location and improvements are contemplated. E. Virgil Neal is president.

LITTLE FALLS—The Barnet Leather Co. is completing an addition to its plant, and plans for the early installation of equipment.

NEW YORK—The Standard Oil Co. of New Jersey, 26 Broadway, has tentative plans under consideration for extensions and improvements in various parts of the country, to include increased production and storage facilities. An appropriation for the expansion will be made from the recent 400 per cent stock dividend declared by the company.

BROOKLYN—Fire, Oct. 30, destroyed the plant of the Kasebler Chatfield Shellac Co., 126 13th St., with loss reported in excess of \$50,000.

Ohio

AKRON—The General Tire & Rubber Co. will soon break ground for the construction of three new additions at its plant, to double approximately the present output of 2,500 tires per day. The structures will be each 1-story, 60x100 ft., 40x180 ft. and 36x100 ft., respectively. William O'Neil is vice-president, in charge.

MARION—The Studebaker-Wulff Rubber Co. has completed plans and will commence the immediate enlargement of its works for considerable increase in output. The new unit, with machinery, is estimated to cost about \$50,000.

AKRON—The Miller Rubber Co., manufacturer of automobile tires, has filed plans for the immediate erection of two 1-story additions to its plant on Cole Ave., 70x105 ft. and 40x42 ft., estimated to cost about \$30,000. It is expected to have the structures ready for service early in January.

Pennsylvania

MARCUS HOOK—The Union Petroleum Co., Widener Bldg., Philadelphia, has arranged for the immediate construction of a number of additions to its oil-refining plant at Marcus Hook, to cost approximately \$500,000, including machinery. A. C. Woodman heads the company.

PHILADELPHIA—The Willden Pottery Co., 711-15 Wharton St., has filed plans for the rebuilding of the portion of its plant, recently destroyed by fire. The work will cost close to \$25,000. The company specializes in the manufacture of flower pots and kindred pottery products.

BLANDBURG—The Harbison-Walker Refractories Co., Oliver Bldg., Pittsburgh, has perfected arrangements for additions and improvements in its plants in this vicinity, estimated to cost in excess of \$750,000, including equipment.

BOYERTOWN—The Eastern Foundry Co. has commenced the construction of its proposed 1- and 2-story plant addition, 100x150 ft., to be used primarily for cast-iron pipe production. A. S. Keptner, 121 Hanover St., Pottstown, Pa., is architect.

BETULA—The Jaeger Glass Jar Corp. has construction under way for a new plant for the manufacture of heavy glass holloware. It is expected to commence the installation of machinery at an early date.

NEWBERRY—The J. K. Mosser Tanning Co. will make enlargements in its local plant to accommodate a branch of the leather works of the Alexander Brothers Division of the Armour Leather Co., Philadelphia, recently acquired. Equipment will be removed at once from Philadelphia to the local plant. The working force will be increased from 800 to about 950 operatives.

PHILADELPHIA—The M. L. Shoemaker Fertilizer Co., Vernango St., has filed plans for the erection of a new 1-story building at its works to cost about \$25,000.

Tennessee

COLUMBIA—The Columbia Oil Co., recently organized by E. E. Williams, McComb, Miss., and associates, has plans under way for the erection of a new local refinery.

MEMPHIS—The Memphis Artesian Water Department is taking bids until Nov. 24 for filtration equipment to be installed at the municipal water works, to include a traveling crane, power apparatus and other operating machinery. Fuller & McClintock, Produce Exchange Bldg., Kansas City, Mo., are engineers.

CHATTANOOGA—The Southern Sheet Steel Co. will take bids at once on equipment for its proposed new local plant for the production of sheet steel and other steel products. It will have a minimum annual output of 55,000 tons and is estimated to cost more than \$1,000,000, instead of \$400,000, as previously announced. Employment will be given to about 500 men. Bids for the buildings will be asked around the close of the year. W. J. Lynch, vice-president and general manager, is in charge.

MEMPHIS—The Strykre Kot-N-Wood Products Co. is perfecting plans for the early erection of a new plant for the manufacture of composition materials at 1040 Oakland Ave., estimated to cost approximately \$65,000.

Texas

TEXAS CITY—The United States Gasoline Corp., has acquired a local site, near the property of the Vacuum Oil Co., totaling about 75 acres of land for the construction of a new four-unit gasoline refining plant, with capacity of 100,000 gal. per day. Work will be commenced at an early date on the initial unit, which is estimated to cost approximately \$250,000, including machinery. The erection of the three other units will follow later.

HENRIETTA—The Griswold Oil & Refining Co. is planning for extensions and improvements in the local Beacon refining plant, lately acquired, to include the installation of a new pipe line.

TEXAS CITY—The Swiftsure Petroleum Co. will make extensions in its storage and

distributing plant, including the installation of additional tanks with capacity of 110,000 gal. and other equipment.

DALLAS—The Dallas Paper Co., 2211 Law St., is planning for the rebuilding of the portion of its works destroyed by fire, Oct. 22, with loss estimated at close to \$60,000.

BURKBURNETT—The Burkburnett Gas Co. is planning for extensions and improvements in its plant, including the installation of additional equipment. Clifford Moore is president.

Virginia

HOPEWELL—The Hopewell China Co. is arranging for immediate extensions in its plant, including the installation of two additional kilns.

RICHMOND—Fire, Oct. 29, destroyed a portion of the plant of the Southern Crockery Co., with loss estimated at about \$25,000. It is planned to rebuild. F. F. Socoloff is president.

RICHMOND—The European-American Tobacco Co., Mutual Bldg., recently organized with a capital of \$2,000,000, has preliminary plans in progress for the erection of a mechanical drying and redrying plant. A local site will be acquired. C. D. Riggon is president.

West Virginia

BUCKHANNON—The Belgrade Glass Co., manufacturer of flint glass tableware products, is considering the rebuilding of the portion of its plant destroyed by fire, Oct. 29, with loss estimated at \$35,000, including equipment.

SHINNISTON—The Alley Glass Co., Bridge St., is reported to be planning for the construction of a new plant to cost approximately \$300,000, with machinery. L. E. Alley is president.

New Companies

THE GENERAL ALLOYS Co., Boston, Mass., has been incorporated with a capital of \$300,000, to manufacture steel alloys and other metals. Henry H. Harris is president; and Charles Van Stone, 426 First St., South Boston, treasurer. The last noted represents the company.

THE OILLESS PAINT PRODUCTS Co., New York, care of J. J. Finn, Yonkers, N. Y., representative, has been incorporated with a capital of \$50,000, to manufacture paint, varnish and kindred products. The incorporators are M. F. Cole, E. Tighe and C. R. Douglas.

THE MID-STATES RUBBER Co., Evansville, Ind., has been incorporated with a capital of \$100,000, to manufacture rubber products. The incorporators are John S. Hopkins and George A. Cunningham, both of Evansville.

THE STEVENS PAPER MILLS, INC., Windsor, Conn., has been incorporated with a capital of \$200,000, to manufacture paper products. The incorporators are L. T. McManus, C. N. Stevens and George C. Russell, 745 Farmington Ave., Hartford, Conn.

THE NEW CHEMICAL Co., Buffalo, N. Y., care of Gibbons & Pottle, Erie County Bank Bldg., Buffalo, representatives, has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical by-products. The incorporators are A. Schneider, M. P. Ryley and B. J. Maler, all of Buffalo.

THE BEACH CHEMICAL Co., St. Louis, Mo., has been incorporated with a capital of \$125,000, to manufacture chemical products. The incorporators are J. M. and J. A. Frere, and M. A. Alexander, all of St. Louis.

THE FULTON MFG. Co., 14 North Main St., Canton, Ill., has been incorporated with a capital of 150 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are A. Judson and Wilmer A. Allton, and Roy E. Wilhoit.

THE GOVE LEATHER Co., Boston, Mass., has been incorporated with a capital of \$10,000, to manufacture leather products. Harold A. Gove, Melrose, Mass., is president and treasurer.

THE NEWTON BELLEEK Co., Trenton, N. J., has been incorporated with a capital of \$50,000, to manufacture chinaware and other pottery. The incorporators are Robert Weelans, Arthur B. Harris and William H. Vollmer, 59 Pierce Ave., Trenton. The last noted represents the company.

THE AMBER VARNISH Co., Brooklyn, N. Y., care of W. S. Miller, 837 Manhattan Ave., Brooklyn, representative, has been incorporated with a capital of \$20,000, to manu-

factory paints, varnish, etc. The incorporators are L. S. and C. Solomon.

THE KANSAS CITY PLATINUM MINING & SMELTING CO., Kansas City, Mo., care of the United States Corporation Co., 65 Cedar St., New York, N. Y., representative, has been incorporated under Delaware laws with capital of \$100,000, to manufacture refined metals. The incorporators are Peter J. Murphy, Byron H. Coon and Joseph R. Lason, all of Kansas City.

THE JACOB W. HOOK CO., 3700 Bank St., Baltimore, Md., has been incorporated with a capital of \$50,000, to manufacture tallow, greases and kindred products. The incorporators are C. Howard and H. R. Hook, and E. H. Requaardt.

THE VERDEX PRODUCTS CO., Indianapolis, Ind., has been incorporated with a capital of \$10,000, to manufacture paints, oils and kindred products. The incorporators are Robert M. Bowes, George G. Rinler and John W. Colley, all of Indianapolis.

THE AUTOCLAVE PORTLAND CEMENT CO., Scranton, Pa., care of the Capitol Trust Co. of Delaware, Dover, Del., representative, has been incorporated with a capital of \$100,000, under Delaware laws, to manufacture cement. The incorporators are H. J. Force, Wendel L. Whitehouse and J. H. Schnieder, all of Scranton.

THE GLOBE OIL & SUPPLY CO., Newark, N. J., care of Kanter & Kanter, 747 Broad St., Newark, representative, has been incorporated with a capital of \$50,000, to manufacture oil products. The incorporators are Charles J. and A. G. Ring, and L. Bennes.

THE MIDDLESEX SOAP CO., Boston, Mass., has been incorporated with a capital of \$50,000, to manufacture soaps, washing powders, etc. William Perkins is president, and Alfred A. Tutin, 63 Dana St., Cambridge, Mass., treasurer. The last noted represents the company.

THE CHARLES V. WALSH CO., Philadelphia, Pa., care of C. Wilson Roberts, 701-3 Franklin Bldg., 133 South 12th St., Philadelphia, representative, is being organized under state laws to manufacture brick and other burned clay products. The incorporators are Charles V. Walsh, F. E. and W. C. White.

THE EMPIRE PLASTIC & CORK PRODUCTS CO., New York, N. Y., care of J. H. Shetron, 116 Riverside Drive, New York, representative, has been incorporated with a capital of \$50,000, to manufacture cork specialties and affiliated products. The incorporators are F. Cutmore and W. E. Smart, Jr.

THE RID-OL CHEMICAL CO., Richmond, Va., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are C. M. Langhorne and John K. Hall, both of Richmond, who will act as president and secretary, respectively.

THE KNOX VARNISH CO., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture paints, varnishes, etc. Howard P. Knox is president; and Herbert B. Morse, 140 Oliver St., Newton, Mass., treasurer. The last noted represents the company.

THE FOUR KINGS MFG. CO., care of Franklin L. Mettler, 832 Market St., Wilmington, Del., representative, has been incorporated under Delaware laws with a capital of \$25,000 to manufacture soaps, washing powders and kindred products.

THE CAPITOL CITY SPECIALTY CO., Trenton, N. J., has been incorporated with a capital of 2,500 shares of stock, no par value, to manufacture polishes and allied products. The incorporators are John and Michael Corse, and Charles Kulov, 19 Gordon St., Trenton. The last noted represents the company.

THE COPPER FLASH OIL CO., Linton, Ind., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are Emery A. Powell, Henry A. Maddox and Nathaniel Hagerman, all of Linton.

THE STARKHOUSE CHEMICAL CORP., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., has been incorporated under Delaware laws with capital of \$100,000, to manufacture chemicals and chemical byproducts.

THE FORT PITT GLASS CO., Pittsburgh, Pa., care of Raymond B. Gabler, 1603 Commonwealth Bldg., Pittsburgh, has been organized under state laws to manufacture glass products. The incorporators are S. A. Greenlee, H. F. Gabel and K. A. Maratta.

THE QUIMBY TILE CORP., New York, N. Y., care of H. R. Korey, 110 William St., New York, representative, has been incorporated with a capital of \$300,000, to manufacture ceramic tile and kindred products. The incorporators are W. Eveleth and W. H. Quimby.

THE MAGNESITE CEMENT PRODUCTS, INC., Boston, Mass., has been incorporated with

a capital of \$100,000, to manufacture cement and affiliated products. Herbert P. Page is president; and Harold H. Smith, 41 Townsend Rd., Belmont, Mass., treasurer. The last noted represents the company.

THE CREO CHEMICAL CO., San Antonio, Tex., has been incorporated with a capital of \$15,000, to manufacture chemicals and chemical byproducts. The incorporators are G. M. Galloway, William Morgan and Russel Myrick, all of San Antonio.

THE H. G. MILLER CORP., New York, N. Y., care of A. H. Rosenfeld, 80 Maiden Lane, New York, representative, has been incorporated with a capital of \$20,000, to manufacture chemical products. The incorporators are H. G. Miller, I. Tilden, Jr., and G. M. Harris.

THE BEACH CHEMICAL CO., Camden, N. J., care of the Corporation Trust Co. of New Jersey, 328 Market St., Camden, representative, has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts.

THE EASTERN STEEL PRODUCTS CORP., Philadelphia, Pa., care of the Delaware Registration Trust Co., 900 Market St., Wilmington, Del., has been incorporated under Delaware laws with a capital of \$500,000, to manufacture steel products. The incorporators are John H. Wilson and Alfred S. Miller, Philadelphia; and H. T. Greenwood, Jr., Merion, Pa.

THE KRO-KO CORP., Smallwood and Eagle Sts., Baltimore, Md., has been incorporated with a capital of \$100,000, to manufacture insect powders, chemical specialties, etc. The incorporators are Donald N. Gilpin, Albert C. Hinrichs and William G. Greisemer.

THE MILLIKEN BRICK CO., Wilkinsburg, Pa., has been incorporated with a capital of \$100,000, to manufacture brick, tile and other burned clay products. John F. Baldwin, Edgewood, Pa., is treasurer and representative.

THE REMINGTON CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The company is represented by J. H. Ide, 1400 Broadway, New York. The incorporators are F. W. Bein, L. Arnoff and S. Mendelsohn.

THE BAXTER PAPER CO., 409 North Holliday St., Baltimore, Md., has been incorporated with a capital of \$25,000, to manufacture and deal in paper products. The incorporators are Wylie M. Baxter, Jr., Stephen S. Mann and Rodney J. Brooks.

THE MIDWEST SUGAR REFINING CO., 326 West Madison St., Chicago, Ill., has been incorporated with a capital of \$1,000,000, to construct and operate sugar refining plants. The incorporators are Arthur E. Dike, John W. Davis and Ira H. McKinney.

THE ELKHART ENAMEL & PAINT CORP., Elkhart, Ind., has been incorporated with a capital of \$50,000, to manufacture paint, varnishes, enamels and kindred products. The incorporators are P. C. Kendall, Fred Carpenter and J. W. Mount, all of Elkhart.

Manufacturers' Catalogs

THE CENTRAL STEEL CO., of Massillon, O., has issued a well-printed booklet of 40-odd pages entitled "Agathon Alloy Steels." An introduction recounts the development of alloy steels for high strength, a development which has taken place mostly during the past 15 years. The rest of the booklet contains useful diagrams showing the physical properties (tensile strength, elastic limit, elongation, reduction of area and hardness) of some well-known steels, as these are measured after various approved heat-treatments. Nineteen of these diagrams are given, several S.A.E. specifications being added to the "UMA" steels and a chromium-molybdenum steel, these being special analyses developed by the Central Steel Co. Appended to each diagram is a brief description of the various machine parts for which that analysis is adapted.

THE MEDART CO., St. Louis, Mo., calls attention to Catalog 43, on line shafting equipment. This catalog, which supersedes all previous catalogs and publications, presents facts about the most generally used line shafting equipment, giving dimensions, details of construction and list prices which should enable engineers, designers, mechanics and power users to plan installations of the equipment described. The book comprises 192 pages with illustrations.

PAUL O. ABBE, INC., New York City, announces a new catalog, "H," which deals with the manufacture of paint under its

patented process in a pebble mill and also covers its special patented mill for doing this class of work.

THE GRISCOM-RUSSELL CO., New York, in Bulletin 910 treats of multiwhirl and G-R vaneflo coolers, exchangers and condensers for oil refineries.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., calls attention to Catalog 85, on the automatic control of temperatures through Brown indicating and recording instruments.

Capital Increases, etc.

THE GULF OIL CORP., Frick Annex, Pittsburgh, Pa., is disposing of a bond issue of \$35,000,000, a portion of the proceeds to be used for expansion, additions to working capital, etc.

THE VITREOUS ENAMELING & STAMPING CO., 1331 Sedgwick Ave., New York, N. Y., has filed notice of decrease in capital from \$400,000 to \$110,000.

THE SHO-ME PRODUCING & REFINING CO., Sullivan, Ind., manufacturer of petroleum products, has filed notice of increase in capital from \$25,000 to \$100,000.

THE SCOTT PAPER CO., foot of Market St., Chester, Pa., has arranged for a preferred stock issue of \$642,700, a portion of the proceeds to be used for general financing in connection with a new plant addition, now nearing completion.

THE CHICAGO BY-PRODUCT COKE CO., 122 South Michigan Ave., Chicago, Ill., has filed notice of increase in capital from \$4,500,000 to \$6,000,000.

THE EVANSVILLE ENAMELING CO., Evansville, Ind., has filed notice of increase in capital from \$50,000 to \$100,000 for general expansion.

THE EMPIRE FLOOR & WALL TILE CO., a Delaware corporation, manufacturer of ceramic tile, has filed notice of organization to operate in New York with an active capital of \$1,000,000. The company is represented by E. C. Luther, 137 West 25th St., New York.

THE AMERICAN SMELTING & REFINING CO., 120 Broadway, New York, has disposed of a bond issue of \$7,500,000, a portion of the proceeds to be used in connection with property expansion.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting in Pittsburgh, Pa., Feb. 12 to 17, 1923.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting April 3 to 7, 1923, at New Haven, Conn.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting May 3, 4 and 5, 1923, at the Commodore Hotel, New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at Richmond, Va., Dec. 7 to 9.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, East 41st St., New York City: Nov. 17—American Electrochemical Society, regular meeting. Dec. 1—Society of Chemical Industry, regular meeting. Dec. 8—American Chemical Society, regular meeting. Jan. 5—American Chemical Society, regular meeting. Jan. 12—Society of Chemical Industry, Perkin Medal. Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting. March 9—American Chemical Society, Nichols Medal. March 23—Society of Chemical Industry, regular meeting. April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting. May 4—American Chemical Society, regular meeting. May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting. May 18—Society of Chemical Industry, regular meeting. June 8—American Chemical Society, regular meeting.